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I. *Main Articles.*

Pages

GEORGE SARTON. — The Teaching of the History of Science. 225

CHARLES H. HASKINS (*Cambridge, Mass.*) — MICHAEL SCOT and FREDERICK II 250

PIERRE BOUTROUX (*Paris*). — L'Enseignement de la Mécanique en France au XVII^e^ Siècle 276

JOHN DAVID BOND (*Baton Rouge, La*). — The Development of Trigonometric Methods down to the close of the xvth Century. (With a general account of the methods of constructing tables of natural sines, down to our days.) 295

II. *Notes and Correspondence.*

R. A. MILLIKAN (*Chicago*). The most important thing in the world . . 322

GUINET. Classiques de la science 322

GUINET. Collection des Mises au point 323

III. *Reviews.*

S. XVI. PACKARD, FRANCIS A. Life and times of AMBROISE PARÉ. New York, 1921 (G. S.) 324

S. XVIII. DIMIER, LOUIS. BUFFON. Paris 1919 (G. S.) 325

S. XIX. OSBORNE, W. A. WILLIAM SUTHERLAND. Melbourne 1920 (G. S.) 326

SCHMIDT, HEINRICH (editor). Was wir ERNST HAECKEL verdanken. 2 Bde. Leipzig 1914 (ERNST BLOCH) . . 328

LEPSIUS B. Deutschlands chemische Industrie, 1888-1913. Berlin 1914 (ERNST BLOCH) 333

Antiquity. SANDYS, Sir JOHN EDWIN. A history of classical scholarship. Vol. I. 3rd ed. Cambridge 1921 (G. S.). 333

SCHMIDT, MAX C. P. Kulturhistorische Beiträge zur Kenntnis des griechischen und römischen Altertums. 1. Heft, 2te Auflage, 2. Heft. Leipzig 1914-1912 (G. S.). 334

TANNERY, PAUL. Mémoires scientifiques. III. Sciences exactes dans l'antiquité. 3e vol. Toulouse 1915 (G. S.). 336

Byzantium. TANNERY, PAUL. Mémoires scientifiques IV. Sciences exactes chez les Byzantins. Toulouse 1920 (G. S.). . 340

China. PETRUCCI, RAPHAËL. Kiai Tseu Yuan Houa Tchouan Paris 1918 (G. S.) 343

Greece. MIELI, ALDO. I Prearistotelici, I. Firenze 1916 (KARPINSKI). 345

Islam. BROWNE, EDWARD G. Arabian medicine. Cambridge 1921 (D. B. MACDONALD) 347

Japan. HOVELAQUE, EMILE. Le Japon. Paris 1921 (G. S.) . . 349

Middle Ages. HEARNSHAW, F. J. C. (*editor*). Mediæval contributions to modern civilization. London 1921 (LYNN THORNDIKE) 350

Rome. ALLBUTT, Sir T. CLIFFORD. Greek medicine in Rome. London 1921 (E. C. STREETER) 353

Anatomy. CHOULANT, LUDWIG. History and bibliography of anatomic illustration. Chicago 1920 (G. S.) 355

Biology. BOHN, G. Le mouvement biologique en Europe, Paris 1921 (GUINET) 357

Chemistry. MEYER, ERNST, Geschichte der Chemie. 4te Aufl. Leipzig 1914 (ERNST BLOCH) 358

GRAEBE, CARL. Geschichte der organischen Chemie. I. Band. Berlin 1920 (A. J. HOPKINS) 359

Geography. MARKHAM, Sir CLEMENTS R. The Lands of Silence. A history of arctic and antarctic exploration. Cambridge 1921 (G. S.), ... 363

Language. MASON, WILLIAM A. A history of the art of writing. New York 1920 (W. LIBBY) 365

Medicine. MEYER-STEINEG, Th. und SUDHOFF, KARL. Geschichte der Medizin. Jena 1921 (G. S.). 366

HÜBOTTER, FRANZ. 3000 Jahre Medizin. Berlin 1920 (G. S.). 367

HOLLÆNDER, EUGEN, Die Karikatur und Satire in der Medizin, 2te Aufl. Stuttgart 1921 (G. S.) 368

Pharmacy. LEWIN, L. Die Gifte in der Weltgeschichte. Berlin, 1920 (G. S.) 369

Philosophy. BURY, J. B. The Idea of Progress. An enquiry into its origin and growth. London 1920 (G. S.) 371

Physics. REICHE, FRITZ. Die Quantentheorie. Ihr Ursprung und ihre Entwicklung. Berlin 1921 (G. S.) 373

Psychology. BRETT, G. S. A history of psychology. Vol. II and III. London and New York 1921 (W. LIBBY) 374

Religion. SPENCE, LEWIS. An introduction to mythology. London 1921 (G. S.) 376

Science, history. SINGER, CHARLES (*editor*). Studies in the history and method of science, vol. II. Oxford, 1921 (G. S.) . . 378

Science, philosophy. MEYERSON, EMILE. De l'explication dans les sciences. Paris 1921 (H. METZGER). 380

DINGLER, HUGO. Physik und Hypothese. Berlin 1921 (H. M. SHEFFER). 383

Sociology. STONE, GILBERT. A History of Labour. London 1921 (G. S.). 383

Statistics. KOREN, JOHN (*editor*). The History of Statistics. New York 1918 (G. S.) 385

IV. *Eleventh Critical Bibliography of the History and Philosophy of Science and of the History of Civilization* (to October 1921) 388

The Teaching of the History of Science

(Second article) (1)

What is the present status of the teaching of the history of science in European and American universities ? The lists and announcements of courses which have been published in various journals (2), may give the reader a very misleading impression. For these lists are many and some are quite long, but most of it is mere bluff. For example, many such courses have been extemporized in America, but, with one exception (CAJORI), I do not know of any course delivered by a lecturer having the rank and emoluments of a professor and devoting himself exclusively to it. To be sure, some of these courses offered as a « side show » by scholars whose main business is to study and to teach something totally different, may be very interesting. Among others, the lectures which the physiologist L.-J. HENDERSON has been giving at Harvard since 1911 have been eminently successful. This exception does not prove anything. Nor does BERTHELOT's example prove that it is generally possible to pursue simultaneously experimental and historical investigations with any considerable success. We owe some of the best work in every field to the capricious efforts of *dilettanti*, but we can never depend upon them and we must of necessity expect the main advances in knowledge to be made by men whose sole duty is to make them and who give their every thought to it. The case of HERMANN GRASSMANN is particularly strange. About 1852, being then in the forty-third year of his age and probably discouraged by the cold reception of his *Ausdehnungslehre* (first published in 1844, it

(1) The first essay, bearing the same title, appeared in the *Scientific Monthly*, September 1918, vol. VII, p. 193-211. The present paper does not supersede the first one, but completes it.

(2) By ENESTRÖM in the late *Bibliotheca Mathematica*; by SUDHOFF and GÜNTHER in the *Mitteilungen*, by MIELI in his *Archivio*, by F. E. BRASCH in *Science* and by myself, though rarely, in *Isis*.

remained practically unknown for twenty years !), he turned his attention to Oriental studies, and he conquered fame as a Sanscrit scholar before being recognized as one of the greatest mathematicians of his day. It does not follow from this that it would be wise to intrust Vedic exegesis to mathematicians, or *vice versa* to expect the Sanscrit instructor to offer, as an additional attraction, some lectures on higher algebra or vectorial analysis. To expect a professor of history or science who is not specialized in the history of science to give a course on this subject is equally foolish. Yet this sort of foolishness or wickedness is becoming very common, for every university seems now anxious to add some course on the history of science to its program, though none is willing to pay the price of it.

This is in itself sufficient to prove that the signification and peculiarities of such courses are not yet understood, even by those who organize them. To form some idea of the present status of this teaching it will be better not to consider the number of courses offered, nor to enumerate the lecturers, for we should risk being deluded. We will consider only such courses as are offered year after year by specialists and which are placed on the same academic footing as other fundamental studies. Let us ask, first of all, how many chairs are devoted to the history of science? The brevity of the answer will be a sharp contrast with the length of the make-believe lists to which I previously alluded.

In America, I do not know of any chair devoted to the history of science proper, but Florian Cajori is professor of the history of mathematics at the University of California. Of other positions enabling the incumbent to cultivate these studies with relative freedom from material care, I know only the one which was founded for me in 1918, by the Carnegie Institution of Washington. If I am not mistaken, that is all for the New World!

Matters are hardly better in the Old World, at least so far as the history of science proper is concerned. I know of only one chair dedicated to it, the one at the Collège de France, which is now occupied by Pierre Boutroux (1). Mr. Boutroux wrote me a few months

(1) His title is « professeur d'histoire générale des sciences ». (While correcting the proofs, I hear that Abel Rey is now « professeur d'histoire de la philosophie dans ses rapports avec les sciences » at the Sorbonne, but that is another subject, as I have shown in my first paper.)

ago that for some time to come his lectures will deal with the history of the principles of mechanics. His chair is the very one which poor COMTE had vainly tried to have established, but which was not founded until 1892, thirty-five years after COMTE's death, and intrusted to PIERRE LAFFITTE. In 1903, the latter was succeeded by G. WYROUBOFF instead of PAUL TANNERY, who was obviously the right man. If TANNERY and later DUHEM had been appointed to it (it appears that political prejudice was the only obstacle to their nomination), this chair would have behind itself the noblest tradition imaginable; but it was not to be. Let us hope that PIERRE BOUTROUX is now inaugurating a new tradition which may make us forget the brilliant opportunities which were lost in the past.

The chair of the Collège de France is to-day the only one in the world devoted to the history of science. It is true, EDMOND GOBLOT of the University of Lyons bears the title of « professeur d'histoire de la philosophie et des sciences », but the emphasis is laid on philosophy, not on science, and GOBLOT's own work is chiefly in the field of logic (1). I should mention as being in the same line the course offered at University College, London. ABRAHAM WOLF is in charge of it with the title of professor of logic and scientific method. His own work is also exclusively in the field of logic (2). Short courses on the history of science have lately been organized under his direction (3), but as I am dealing here only with regular and permanent courses and not with makeshifts, I can not consider them.

The situation is even worse than it seems at first sight, if one remembers how many chairs are devoted to historical studies. In the latest Harvard catalogue (1920-1921), I find that not less than thirty-five members of the faculty are primarily engaged in historical teaching of some sort, the history of science alone being excluded. There are thus in the world thousands of professors of history, but only one of them is teaching the history of science! Shall we weep or laugh? The history is taught of everything under the sun, except science; yet we call this age of ours, the age of science! A moment's reflection will convince anyone that the only human activity which is truly

(1) *Isis*, III, 306.

(2) I know two books of his : *The existential import of categorical predication*, Cambridge 1905, and *Exercises in logic and scientific method*, London, 1919.

(3) *Isis*, III, 419.

cumulative and progressive is scientific activity, — the acquisition, accumulation and transmission of knowledge. The only conquests which are final are our conquests over ignorance. Thus any history of humanity should be focussed upon the progress of knowledge; that should be the thread, the *leitmotiv* of the human epos. Yet that very part of our annals is either ignored or treated in such offhand and scandalous fashion that complete silence would be more reverential.

I have spoken thus far of the history of science in general. The situation is better with regard to special sciences or groups of sciences. CAJORI's teaching at Berkeley has already been mentioned. The chair of Heidelberg has been made famous for ever by the late MORITZ CANTOR (1). There may be, at least in Germany, a few other chairs devoted to the history of mathematics. It is in the medical domain, however, that historical studies have been organized in the most elaborate manner. The Institute for the History of Medicine founded at the University of Leipzig by the munificence of TH. PUSCHMANN has become, under the direction of KARL SUDHOFF, one of the greatest historical institutes in the world. There are also historico-medical institutes and chairs at the University of Vienna (MAX NEUBURGER) and Jena (TH. MEYER-STEINEG) and there may be still others : I have quoted those which are, and justly so, the best known. I do not know of any chair for the history of medicine in any other country, though lectureships are fairly common. At one time (1863-1891), ANGELO CAMILLO DE MEIS (2) was professor of the history of medicine in Bologna, but he was never replaced.

The privileged status of the history of medicine calls for some explanation. How shall we account for it? For one thing, the history of medicine has always attracted far more attention than the history of other sciences or techniques, because of its intensely humane character. Try as you will, the history of the medical art can never be divested of its human element. The average man is more likely to be interested in the riddles of disease and death, which confront him at every step, than in the principles of geometry or mechanics. This interest will easily take an historical turn, for the solution of riddles evokes anecdotes; men are naturally fond of anecdotes, and anecdotes belong to the past. On the other hand, the clinical and historical points of view have something in common and

(1) He has been succeeded by KARL BOPP.

(2) *Isis*, IV, 421.

the physician is perhaps more tempted than any other scientist to delight his well-deserved leisure with historical research. This explains why the literature of medical history is so enormous and also why so much of it is rather of an inferior quality, — more in the nature of anecdote, gossip and idle antiquarianism than of philosophical history.

The most important feature of the history of medicine, however, is that it is, in fact, far more comprehensive than its name would suggest. Textbooks on the history of medicine are not by any means restricted to medical topics; they deal as well with anatomy, physiology, botany, even to a certain extent with chemistry, arithmetic, astrology, etc. For the mediaeval period down to the xvith century, some of these histories might be passed off as histories of science. At any rate, physicians are generally ready to take them as such, for they are not philosophically minded, they hate abstractions, they ignore the more exact sciences and are satisfied that the history of medicine gives them all that is really worth knowing of the history of science.

Thus did it come to pass that the history of medicine, — having considerably enlarged its natural scope and received a sufficient elaboration at a comparatively early date, — filled the needs and gratified the curiosity of a large part of the students who might have become interested in the history of science proper. From this point of view it may be said that the earlier and greater success of historico-medical studies has temporarily impeded the progress of our own. At all events, this does not matter much, for whatever historical research was done by historians of medicine either in their own or in neighbouring fields, *is* done. They have helped to develop methods which can easily be extended to similar investigations with regard to other sciences, they have created model institutions which it will not be difficult to render more comprehensive, they have awakened an historical interest which may be progressively diverged to the broader sphere. And whatever errors of interpretation were due to their peculiar point of view, their onesidedness and their ignorance, will be easily righted in the course of time.

To appreciate properly the present situation of the teaching of the history of science, it will be well to compare it with that obtaining in other historical departments comparable to it, chiefly the history of art and the history of religion. A comparison with the latter is particularly apposite, and I will come back to it presently. As to

the former, its situation is incomparably more favorable. There is no college, I am sure, that has not at least one chair devoted to the history of art. In the larger colleges a whole department is devoted to art, though the greatest part of its activity is naturally absorbed by practical rather than historical subjects. But this teaching suggests another comparison. We have seen that the history of medicine has to a large extent supplanted the history of science proper. In the same way, the history of the so-called « fine arts » has superseded the history of art to such a degree that the average man very often mistakes the former for the latter. This comparison should not be carried too far, however, because the situations of both cases are reversed. The history of the more abstract and the purer kind of art has drawn most of the attention, while the applied or decorative arts have been comparatively neglected. On the other hand, it is the applications, chiefly the medical applications, of science that have first engrossed the historian's interest, at the expense of the more abstract disciplines. To put it more briefly, man's historical curiosity has been (and is still) arrested primarily by the highest forms of art and the lowest forms of science.

II

A comparison with the history of religion is extremely instructive, for the present status of our studies is very similar to its own some fifty years ago. Before that time the history of religion had been considered by the theologians and the educated public either with undisguised disfavour, or (and this became gradually the more common attitude) with that polite indulgence which one readily grants to curious but futile investigations. When the first courses were organized, it was thought that almost any theologian could prepare them, an assumption which was the further from the truth in that at that time scientific textbooks on the subject were not yet available. The first good textbooks appeared only at about the end of the last century (1). The first chair devoted to the history of

(1) Cornelis P. Tiele, *Geschiedenis van den godsdienst tot aan de heerschappij der wereldgodsdiensten*, Amsterdam, 1876 (English translation, London 1877). — Chantepie de la Saussaye, *Lehrbuch der Religionsgeschichte*, 2 vol., Freiberg, 1887-1889. The second edition prepared by Chantepie with

religion was established in Lausanne in 1871. Then followed in quick succession : Genève and Boston, 1873; Oxford (Manchester College), 1876; Groningen, Leyden and Utrecht, 1877; Amsterdam and Upsala, 1878; Paris (Collège de France), 1880; Brussels, 1884 (1). In 1870, there was not a single chair of the history of religion, and the scientific and systematic study of this subject had not yet begun. Thirty-four years later, in 1904 (2), there were scattered all over the world not less than thirty chairs, and the history of religion had become solidly established as an independent discipline, having its own methods and instruments, its own traditions. The days of chaos were past; it was no longer believed that anyone could study — not to say, teach — the history of religions without special training; museums and schools had been founded, and their doors were carefully guarded.

The reader will readily forgive me for having spoken of the history of religion at a greater length than he would probably expect in an essay on the history of science, for could anything give us more courage and inspiration than this brief history of a discipline so closely related to our own?

In 1870, the history of religion did not exist; to-day, it is safe to say that at least one chair is devoted to it in every university or seminary worthy of the name.

This preamble makes it easy to explain my own ambition. We are starting almost from the point whence the TIELES and the CHANTEPIES started fifty years ago. We must emulate them and exert ourselves to such an extent that fifty years hence the faculty of no university or college will be deemed complete if one at least of its members be not exclusively engaged in the study of the history of science.

I am writing this in the autumn of 1921. I am ready to fight for

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the assistance of a few other scholars (1897, French translation 1904, third German edition 1905), was probably the first satisfactory textbook, though it did not include Christianity.

(1) It is interesting to note that small nations like Holland and Switzerland took the lead. Holland's credit is particularly great because the teaching of the history of religion was from the beginning in the hands of masters : TIELE in Leyden and CHANTEPIE in Amsterdam. The first incumbents in Paris and Brussels were respectively ALBERT RÉVILLE and GOBLET D'ALVIELLA.

(2) My information is derived chiefly from LOUIS HENRY JORDAN, *Comparative religion. Its genesis and growth*, Edinburgh, 1905.

this cause and I will not retire alive from the arena until I have won (1). I will not lay down my arms if at least twenty chairs devoted to our studies do not exist by the year 1941, — and if there be not at least fifty of them by the year 1971, I will not hesitate to jump out of my grave and fight all over again.

The history of religion has been established as an independent discipline during the last quarter of the past century; it is our sacred mission to establish the history of science as an independent discipline during the second quarter of this century. We must work so hard and so well that other scholars will be obliged to recognize the independence and the fundamental importance of our studies; we must elaborate and systematize the necessary methods and instruments; we must create traditions which enforce obedience, discourage amateurish efforts and render unskilled teaching unthinkable.

It is also our particular duty of the moment to make it clear to university presidents, deans and other authorities that, if the teaching of American or Greek history is considered as a man's job, *a fortiori* the teaching of the history of science must be. For in the first case there are excellent textbooks, dictionaries, and various other intellectual tools; the subject has been studied from every angle; the main points have been emphasized and the moot questions discussed over and over again; the teaching itself is well-nigh standardized. In the second case, there are only numerous and often conflicting monographs written by various scholars in many languages; there are no exhaustive textbooks (2) and the instructor is left to find and clear his own way in the bush. It is our duty to hammer into their heads the conviction that to intrust the teaching of a new subject to non-specialized scholars and especially to those who have already other scientific obligations and can devote only a small part of their time to the new ones — is a joke and a very bad one at that. And when they do so it is our duty to proclaim their foolishness, their incapacity, and to give them generously all the discredit and ridicule which bad educators and ignorant administrators fully deserve.

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(1) To avoid any misunderstanding, I hasten to add that I have personally no wish to become a professor. *Sic ego non mihi...*

(2) Fr. Dannemann's book is satisfactory as far as it goes, but it is elementary (*Isis*, IV, 110).

III

It is useless to discuss the teaching of the history of science if one has not thoroughly understood the double origin, the double nature of this discipline. Its name is sufficiently significant, but one often overlooks the obvious. The *history* of *science* is a historical discipline; it is also a scientific discipline. The historian of science must have a sound knowledge of two sets of facts : historical facts and scientific facts. He must be familiar with the methods required to ascertain and to interpret these two kinds of facts. It would serve him little to be a good scientist, if he had no historical sense, no historical training; it would serve him less to be a well-trained historian if he had no understanding, no knowledge of science.

To make this clearer, let us consider again the branches of learning more comparable to our own : the history of art and the history of religion. If the historian of religion were deprived of religious feeling and religious experience, he would be doomed to make capital blunders at every step. His learning would be but dead and senseless pedantism; it would be worthless. The case of the historian of art is even more manifest : of what use would it be to him to know the names and dates of the old masters if his heart did not understand their silent voices ? The art critic who has not himself the temperament of an artist is doomed to failure. He may know all the details; he is unfit to understand the essential.

In the same way, the historian of science who does not grasp the scientific facts and theories (it does not generally suffice to know the definite facts in question; one must be able to grasp whole series of related facts and to seize the trains of thought involved by them), who has no scientific experience and feeling, is bound to make essential mistakes, irrespectively of his learning. Historical and scientific errors must be equally avoided, but many historical errors are only venial offences, while the scientific errors are deadly sins. The former, indeed, imply merely a misapprehension of the accessory circumstances, while the latter prove that the very substance of one's investigations has not been understood. Imagine a teacher explaining to his audience the theory of homocentric spheres. He might fail to introduce it properly, and the lack of historical perspective would unduly increase Eudoxus' fame at the expense of

his predecessors; this would shock us but we might forgive him. Imagine now that his historical account be perfect but that he proves his inability to understand the theory itself. What confidence could we have in him ? When the fundamental facts are wrong (and in our case, these are the scientific facts) we do not even care to know whether the historical circumstances are right or not.

One may object that those who deal with mediaeval or oriental science do not need as much scientific knowledge. That is true but only to a certain extent. It is true enough, for instance, that we owe some of the best work on mediaeval science to historians who had not received any scientific training. Such exceptions do not prove anything, and we must remember on the other hand that the two greatest students of mediaeval science of our time are (or were) professional scientists : KARL SUDHOFF and the late PIERRE DUHEM. It is obvious that their work could not have been done by laymen. Besides, the field of mediaeval science gives us but too many examples of erudite research vitiated by scientific ignorance. A common source of error is the confusion between mediaeval and modern terminology, and the extension to the former of connotations of a much later date. This applies particularly to studies on Hindu science. Finally, I must point out that there is a great difference between learning and teaching. A mediaeval scholar without scientific training may yet carry on investigations of great value, for if he be prudent enough to avail himself of expert advice he will easily avoid the scientific pitfalls. He may thus produce excellent papers and yet remain unqualified to teach mediaeval science, for he could not appeal to his scientific adviser in the course of a lecture, and a teacher must be able to give additional elucidations and to answer troublesome questions.

I hope that my emphasis upon scientific errors will not be misconstrued. If I were to say that killing a man is a worse offense than cheating at cards, this would not mean that I condone cheating. There is a hierarchy of sins, there is a hierarchy of errors. When I say that, for the historian of science, scientific errors are generally mortal, I do not mean that historical errors are of no importance. We must try to avoid them by all means. Historical facts are valuable only to the extent that they are accurate; it would be foolish to collect worthless material. Our ideal of historical truth can never be placed too high.

IV

Granted the priority and essentiality of scientific facts, it follows that the historian of science, especially the one engaged in teaching, should be primarily a scientist and secondarily a historian, a philosopher. There is another reason, hardly less cogent, why his training should be primarily scientific. This is the well-known fact that scientific knowledge, and even more so, scientific methods and points of view, must be assimilated while one is young; that is the more true that the sciences considered are more abstract. In the extreme case of mathematics, it may well be said that he who has not studied them before he was twenty or twenty-five will never be able to master them, for he will never again find the time nor have the persistent and docile energy which are needed to complete such systematic training. The same might be said of experimental work; experimental habits must be made in youth; we can not fully understand the experimental spirit unless early practice has caused it to impregnate our own substance (1).

On the other hand, historical training, difficult as it is, can be eventually undertaken later. The true historical spirit is innate rather than acquired. And as to historical understanding, it can but increase as we gain more knowledge of the world, more experience of life. Children cannot possibly understand history; they misunderstand it systematically. Indeed, there are many historical facts which can not be appreciated except in the maturity of one's age, when personal experience has revealed the true meaning of human passions, when one has been able to measure their violence with one's own heart. It takes many storms to make a good sailor. For example, familiarity with the political conditions of one's own day will help one to judge the political problems, the political passions and crimes of the past. Thus the older one becomes, the better does one understand political history, — and history in general.

One must also take into account the extreme interdependence of scientific facts, the rigorous concatenation of scientific theories,

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(1) It is for these reasons that I advise young students interested in the history of science to study as much mathematics and carry on as much laboratory work as they can. It is for them a matter of now or never.

which makes it generally far more difficult to understand isolated facts or theories than is the case in the historical domain. One unfamiliar with physics and chemistry will be unable to read with any profit a book on spectroscopy, while he will find no essential difficulty in reading and following the history of Ethiopia even if his previous knowledge of the subject, and of history in general, is very small.

I think we may now consider as proven that early and thorough scientific training is the prime qualification of the historian of science. The next question is then naturally, what should be the extent of this training? To be ideal it should be encyclopaedic. Such training is not at all irrealizable, but the number of people having undergone it is of necessity very small (not because of any insuperable difficulty, but simply because of a lack of organization, because it is not « done »; I will come back to this presently) and we must take into account existing conditions. We must frankly admit that if the teaching of the history of science were suddenly organized on a large scale — if, say, ten chairs were established at once — it would be well-nigh impossible to find men fully qualified to occupy them. That would be no serious obstacle, however, for it would be much easier to find scholars ready to teach the history of one science or group of sciences, and the more general teaching might be temporarily replaced by a more special one. It is in the nature of things that the first teachers, the pioneers, are inferior to the later ones, even though their inspiration be of a higher quality. Our best works are nothing but stepping stones for our followers.

It would be unwise to insist at once upon the necessity of an encyclopaedic training, but there are minimal requirements which should be satisfied in any case. It would be unadvisable, for instance, to intrust such teaching to men having no experimental training whatever. This training can not be obtained simply by the making of artificial experiments — such as those prepared for the students in college laboratories — the results of which are known beforehand. It is necessary to have made at least a few genuine experiments, experiments in the unknown. A minimal knowledge of mathematics should also be required (except for those restricting themselves to the history of medicine), and this minimum should include at least some familiarity with analytic and synthetic geometry and infinitesimal calculus. For without such knowledge it would

be impossible to speak tolerably (1) of such men as ARCHIMEDES, APOLLONIUS, DESCARTES, HUYGENS, NEWTON, LEIBNIZ and EULER, and a course on the history of science containing no account of them would be very much like the play of HAMLET without HAMLET.

Keeping these minimal requirements in mind, one could rightly expect the teacher to be able to expound the whole history of science down to the beginning of the last century (with more emphasis on the subjects he knows best and a more superficial account of the others). He should not be expected to explain the latest developments except of those sciences with which his special training has caused him to become more familiar.

Courses on the history of science should have the same flexibility as courses on the history of art or religion. The teacher to whom the latter are intrusted should not necessarily be expected to devote as much attention to every religion or sect or to every phase of their development. If he were an Arabic scholar, he would be justified in giving relatively more time to Islam and thus letting the students share the fruits of his studies, or else a bent to ethnography might induce him to treat more fully the more primitive stages. A professor of art might be more interested in painting and (after due warnings to his audience) there would be little harm in his neglecting relatively the other arts to lay more emphasis on the history of painting. In this case, however, he would be frequently obliged to deal with the other branches of art merely to explain the development of his favourite one. In the same way, the historian of science could never neglect too much any branch of knowledge, for the evolution of every branch is simultaneous and none is independent of the others. It is impossible to understand the development of any one science without reference to the others. Even then, the professor of the history of science should remain unusually free in the selection and the treatment of his subject. Administrators should always be ready to sacrifice programs to personalities. They should never forget that the presence of a real scholar in their midst is an inestimable blessing. Even if he be a poor teacher, his very presence

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(1) I do not say *to explain* their work, for this would require a far deeper knowledge of mathematics. For example, a very sound knowledge is indispensable to explain the development of Greek mathematics and astronomy. A knowledge of elementary geometry is not at all sufficient to interpret EUCLID.

is an inspiration. There are hundreds of good teachers for one original and complete scholar.

To be more specific, we might divide roughly all scientists into three groups : biologists and naturalists; physicists (including chemists and astronomers); and mathematicians. If the training of a prospective teacher had been chiefly biological, he might be expected to teach the history of science down to about 1800, with special emphasis on natural science and biological problems. He might give also a course on the history of biology down to our time, a course which would naturally culminate in a discussion of the main problems of our day and possibly in a vision of the future. In his general course, he should be allowed to skip over the mathematical subjects, though it should be made clear to him that he would improve his qualifications by a certain amount of mathematical study. In a similar way, the physicist would become a far better teacher of the history of science if he would study some biology. The best for him would be to spend his summer vacations in a biological station, like Naples, Wimereux, Roscoff or Woods Hole, where he could pleasantly divide his time between investigations along the beach and rocks, interviews with his expert colleagues, and microscopical or experimental work in the laboratory. The case of the mathematician may be more difficult. The pure mathematician — I mean the one with no experimental training and a marked predilection for the more abstract subjects — should not attempt to teach the history of science, though he might be able to give an interesting course on the history of logic and mathematics. The average mathematician, however, has received some training in experimental physics, and is interested in various applications. He might become an excellent teacher of the history of science, if he would spend his vacations in a biological station, undertake if possible some experimental research and take advantage of every opportunity to visit laboratories, workshops and mills. He should indulge in frequent discussions with engineers and inventors. They would gradually inculcate on him the difference between mathematical possibility (the absence of internal contradiction) and practical possibility. He should be made to realize it repeatedly in different ways and he should learn also to distinguish the many degrees of possibility and the conditions of each.

To sum up, the only unqualified scientist is the lopsided one, he whose knowledge is abnormally developed in a single direction and

who has lost touch with the rest of science (it is hardly necessary to point out his disability to him, for he is depressingly aware of it, but he will seldom admit the qualifications of others !). Of the specialized scientists, none is better prepared than the biochemist, if he has received a good mathematical and physical training. For his own speciality is located, so to say, at a strategic point; he has learned to appreciate the cardinal problems of many sciences. But even to him we should prefer the scientist who, after a long training both theoretical and experimental, has chosen for his life-work the study of general science — we might call him the specialized encyclopaedist. His particular training makes it much simpler for him than for any other scientist to observe the life and analyze the congruity of science, to watch its increasing unity amidst innumerable changes, to follow the growth of the tree of knowledge and of every one of its branches, to survey with comparative ease either the total knowledge of any one period or the evolution of some special science throughout the ages.

V

The historical method has been so often used in elementary and popular handbooks that to many people the phrase « history of science » conveys vaguely the meaning of « introduction to science ». The misunderstanding has been aggravated in America by the organization of courses on the history of science, which are professedly introductory. Their aim is to offer to the students at the beginning of the curriculum a sort of bird's-eye view of the whole of science in order to facilitate their choice of a proper direction.

There is little doubt that the historical method is excellent for that purpose. It is also the most natural one. Each man must somehow retrace the whole evolution of his ancestors. The historical method consists in replacing him in the psychological status of early man and in making him retrace step by step, though more rapidly, the intellectual progress of mankind. This method is extremely pleasant and suggestive, and it is remarkable how much knowledge can be imparted by its means to an intelligent audience. However, its limits are very quickly reached. The journey already accomplished by man is so immense that, even if one avails oneself of all the historical short cuts, the advance made possible by this method is too slow

and precarious. It is soon found necessary to use other methods which are almost the reverse of the chronological one. One starts from the latest notions instead of the most primitive, and one readily reconstructs the edifice of knowledge without reference to the accidents of discovery. In both cases the progress is from simplicity to complexity, but in the historical method the elements are simple by their concreteness, in the synthetic method they become simpler by increasing abstraction.

The use of the historical method is limited not simply by the lack of time, but also because as soon as one needs more than a bare outline, it becomes unmanageably complex. It is not possible to teach a subject and its history at one and the same time. The best method (one which every author has been gradually led to follow) is to give at first a brief historical outline which awakens the student's curiosity and makes it easier to define the field and the purpose of the science one is dealing with; then to abandon the historical order altogether and teach the subject in a systematical manner; finally to teach the history of the subject, thus enabling the student to review his knowledge from a different point of view and to deepen his understanding of it. The last stage — the true historical one — is frequently omitted, because its importance has not yet been fully realized and because the practical needs of the student are satisfied at the end of the second and he generally lacks the disinterested curiosity and the enthusiasm which are necessary to go any further.

Certain « introductory » courses written along the historical method (MACH's mechanics is the best example) are as simple as they are deep, but this simplicity is rather deceptive. At least the meaning of such books is disclosed only to those who have already a thorough knowledge of the subject. One encounters the same fallacy with regard to other elementary books. A summary is relatively richer in facts and meaning than a complete textbook, but the profit that we can derive from it is strictly dependent upon our memory of all the substance which it represents. The complete and seasoned scholar may find much to please and instruct him in a good elementary book, but it would be foolish to imagine that the same book will be equally instructive for an apprentice. Where the latter can but see a curious, if not a repellent, skeleton, the master will evoke at a glance the flesh and life around the dry bones. It takes a wise man to understand a primer.

When I am speaking of the history of science, I am not thinking of these historical introductions; it is hardly necessary to worry about them. The teaching I am thinking of is, on the contrary, a sort of conclusion to be offered only to advanced students, in their last year. It should be to them, before their departure from the college, the supreme humanistic initiation. It would involve a sort of synthetic review of their studies. They would have taken courses in science, in literature, in art, in history. This final course on the history of science would reveal to them the interrelations of all these parts, it would show them that they are but fragments of a single whole; it would expose to their view the magnificent harmony, the congruity, the unity of knowledge.

As I said a moment ago, an attempt has been made in some universities to offer such a course at the beginning of the curriculum, but it is then necessarily restricted to vague generalities and, even so, how much of it do the students understand? I think it is wiser to place it at the end, for a good deal of intellectual experience and maturity is needed to benefit by it: this teaching will be the more pregnant to each student that he has already acquired more knowledge.

Indeed, knowledge bears interest like money; the richer one is, the easier it is to get richer still; the more and better one knows, the easier it becomes to increase and improve one's knowledge. It is encouraging to realize, for example, that because of the unity and consistency of science, it is possible to understand its development much beyond one's own direct experience, that is, provided one's initial knowledge be sufficient and of good quality. If a student has taken the pains to carry on investigations along a certain line, and if he has conducted genuine experiments — experiments followed by frequent deceptions and perhaps finally rewarded by the discovery of a new fact, however humble — he will easily understand the meaning of other experiments not simply in the same field, but even in totally different ones. For the elements of experimentation are essentially the same in every field, and the most complicated and forbidding apparatus are made up of elements which are relatively simple and belong to a relatively small number of types. The same can be said of scientific method in general. An intelligent scientist can understand and appreciate the work of fellow scientists, even of those who are engaged in research widely different from his own. A

sound scientific initiation is indispensable to such understanding, but it does not matter so much which. This comparison might even be pursued outside the sphere of experimental science. Let us again consider the history of religion, for example. It is clear that a scholar who has made a deep study of the development of one religion will find it relatively easy to understand the vicissitudes of another, for the human motives and the psychological problems involved are essentially the same in every clime.

As far as the scientific aspect of this teaching is concerned, it is hardly necessary to press the point : one's interest in the history of a thing can but increase as one becomes more familiar with it. The advantage of late instruction is not less obvious from the historical point of view, though a course on the history of science and civilization (that is, a history of civilization focussed upon the progress of science) can be made very interesting to an audience having but little knowledge of history. I have made the experiment more than once. I have lectured on Greek science and civilization, for instance, to boys whose whole past — whose living past — was at most two centuries deep : the depth of a skin. Yet I managed to entertain them and they entertained me too, for such ingenuity is not without charm. I prefer, however, to lecture to more sophisticated people, who have already obtained some sort of historical background and a sense of perspective. It is a great pleasure to be able to reveal to them that the history with which they are already familiar is not by any means the whole story, and to make them realize gradually that the history of mankind is double : political history which is to a large extent a history of the masses, and intellectual history which is largely the history of a few individuals (1).

The first development is the obvious one; it is the one which has thus far claimed the attention of historians almost exclusively. The peoples of the earth and, within each nation, the different classes of men, are not equally fertile, ingenious, energetical, ambitious. Their ambition — in the case of peoples one calls it, often, imperialism — is a function of their strength and vitality. If they become conscious of their superiority without being restrained by moral or religious motives, they are bound to become aggressive. Between strong, numerous, hungry people on the one hand and effeminated

(1) For further development of the same idea, see my essay on Secret History, *Scribner's Magazine*, vol. 67, p. 187-192. New York, 1920.

people, weak, scarce and replete on the other, there arises, so to say, a difference of potential which, if it reaches a certain limit, causes a sudden disruption, — war or revolution. Political or economic history can thus be explained in terms of forces chiefly material. (At least in theory, for in most cases the complexity of causes is too great to admit of a strict analysis, and we must be content to register most historical disruptions as we register earthquakes or cyclones : we know the causes, but only in a general way, and our hold on them is very weak.) To be sure, other factors than the material must be considered — moral and religious factors, for instance, — but the fundamental causes are material. Leaders may exert a deep influence and modify the course of events, but only to a limited extent, for their energy remains always a function of the energy of their following. They can lead only to the extent that they avail themselves of existing passions, of the differences of potential which already obtain : they can not create these differences, but they can make use of them in various ways; they can delay the discharge or else provoke it and modify its nature.

The second development is far less obvious; in fact, so far as the majority of people is concerned, it is almost secret. Yet it is the development of the activities which are most specifically human, the development of all that is best in humanity : I mean the development of art, of science, of justice, of moral and religious ideals; in short, the creation and evolution of spiritual values. These values are created by individuals; in most cases, isolated individuals. CAESAR and NAPOLEON can not accomplish their destiny without the collaboration of millions; SPINOZA, NEWTON, PASTEUR do accomplish their own in seclusion. They thrive best in solitude. The elaboration of their sacred task — the very fulfilment of human destiny — is to a large degree independent of circumstances. At least, external circumstances seem purely accidental, not really creative. Society can poison SOCRATES, crucify JESUS or behead LAVOISIER; it can not cause them to be born, it can not dictate their task.

It is, as I said, a very great pleasure to reveal to a young audience this second but essential aspect of human history — the very course of human progress — for they know generally but little of it, and what they know has been obscured by the large mass of irrelevant and indifferent facts. They see kings enthroned, peoples in arms; they hear the clash of armies or of mobs; they may even hear the

impassioned orations of statesmen or rebels. But how could they see the poor philosopher working in his miserable garret; the artist wringing under the load of his inspiration; the scientist pursuing silently, obstinately his self-imposed quest? It requires more wisdom and imagination than they can possibly have to see these things. But they may know pretty well the historical background. It is then the estimable privilege of the historian of science to place in front of it the small but central figures.

Of course when the history of science is more generally known a greater place will be given to it in the regular courses of history, but even then the supreme historical teaching will have to be delayed until the end of the studies; it will remain a conclusion, not an introduction, for the reasons which I have already set forth.

As I see it now, historical teaching will proceed in the following way: the first teaching will be primarily political and economic; that is, the teacher will paint the background first. In later stages he will then introduce gradually the central figures and he will bring them out more distinctly as the knowledge and experience of the students increase: — the artist, the seer, the thinker, the scientist, the saint.

This order is the natural one. We must expect young students to be interested chiefly not in our highest but in our most primitive activities. Our deepest motives are centered upon such primal matters as food and shelter; love and hatred; business and play; health, disease and death. Besides, it is the abnormal conditions, not the normal ones, which excite the greatest curiosity. One needs the cold language of statistics to describe normality with any accurateness; but abnormalities are always sufficiently conspicuous; they need no barking at the door; they oblige us all to pause. It is not peace and plenty, therefore, but war and famine which interest the people most; not sanity, but insanity; not health, but diseases and plagues; not the soundness of love, but its perversions and irregularities. And the cruder the people, the more eager is their concern in monsters and oddities: the publishers of the yellow press know it full well. I will readily confess that when I am myself too tired to study or meditate, I have still enough energy to read the newspaper's gossip. That is, when my better self is exhausted, I can still draw upon the more primitive curiosity which is dormant a the bottom of my heart. All this explains why it is the conven-

tional history (one might call it the pathological history of humanity) which interests man first and most.

It is thus better perhaps not to quarrel with the old-fashioned historian : let him do as he is wont and give the people what pleases them most. They like to hear of wars and revolutions, of kings and princesses. They love the pageantry of the past, the pageantry and the scandals. Let them have them ! That is the background of the picture; they will have to know it at any rate, why not first ? There can be no objection to that, but we have a right to insist that some historical course, revealing the essential and putting matters in their true perspective, be given at the end of the curriculum. This would be the supreme humanistic initiation. And I add : let the historian of science do it, for he alone who is equally familiar with science and history, is fully qualified to explain the true nature of human progress.

VI

The history of science is an encyclopaedic discipline. It will stand or fall as we accept or not the possibility of encyclopaedic knowledge. I claim that such knowledge is both necessary and possible (1).

It is necessary as a coördinating and harmonizing agency; the very progress of special research would become more difficult without it. It remains possible because the increasing extension and complexity of science are largely compensated by its consistency and its progressive unification. To deny the possibility of encyclopaedic knowledge is almost as foolish as it would be to say that it is impossible to draw a geographic or geological map of the world. And yet such maps are being drawn, and they were already drawn a long time ago, when our geographical knowledge was considerably smaller than it is now. It is necessary to do it periodically, each time that science has reached a higher level, in order to inventory our knowledge, to determine more exactly our ignorance and to guide and ease further advance. To every stage of the progress of science there corresponds a stage of encyclopaedic knowledge which is, so to say, the image or the map of science at that particular time. The gaps of our knowledge are no obstacle to it : they are simply

(1) I have developed this point in my paper on HERBERT SPENCER, *Isis*, III, p. 375-386. 1921.

the blank places, the *terrae incognitae* of the map, and nothing is more inspiring to the future explorer than to see them there and then in their proper relations to the better-known territories.

Encyclopaedic knowledge is not necessarily more difficult to obtain than any other. Nor is it necessarily vaster than any special ized knowledge, for its elements are different. There are as many names on the map of Massachusetts as there are on the map of the world, but they are names of a different kind. It is true, encyclopaedic knowledge requires special qualities; it is hopeless to attain it unless one be endowed with a synthetic intelligence. But that is equally true of any occupation : it takes a collector's mind to collect insects, at least to do it well; it takes a computer's mind to prepare a table of logarithms. It is easy enough if you have the right brains; it becomes impossible if you have not.

Encyclopaedic knowledge is relatively rare, not because of its difficulty, but rather because very few attempt to obtain it, or, if they do, do it in the right way. There is no tradition to help one, there are no traced roads to follow, and one can not become an encyclopaedist as passively as one becomes a physician or an electrical engineer. Yet the increasing specialization of knowledge will sooner or later make it imperative to create professional coördinators (1).

To quote a single example, it would not be unreasonable to expect university presidents to be encyclopaedists. It is true that under present circumstances (2), they have so much administrative work and so many social duties (outside of the faculty) that the training of a diplomat or of a banker may suit them better, and that they need entregent more than knowledge. However, as the administrative burden increases it will soon be necessary to divide the intellectual and the administrative functions, and the more so that they are essentially different. This may be the best way to check the progressive industrialization of American universities (3). There must

(1) For the sake of concreteness, I propose to publish in an ulterior paper the outline of a complete curriculum. A course of seven years would be quite sufficient for anyone having already received a solid secondary education, such as is obtainable in a French *lycée*.

(2) It is the American conditions which I have particularly in mind in this paragraph.

(3) Of course this is partly caused by their tremendous growth. Every living creature has an optimal size. It is likely that there is also for each institution

be some coördinating agency between the members of the various faculties, and the coördination must be of the highest order; mere administrative coördination is almost worthless beyond its own limited range. The president to whom the intellectual leadership would be intrusted would need possibly an encyclopaedic education, and in any case a scientific one. Some fifty years ago it was assumed that a college president could be chosen only from among the theologians. Fifty years hence the presence at the head of a great institution of learning of a man having no other training than a literary or legal one, will appear as incongruous as that of a minister would now, and for the same reason. It will be generally assumed that the head of such an institution must have a minimal understanding of the activities over which he is expected to preside. Literary men, of course, will maintain that they do not lack that understanding, for few of them have yet realized the seriousness of their ignorance. But the plain, if unpleasant, fact is this : there can not be complete reciprocity between the literary man and the scientist, for the latter can understand the former, while the former can not understand the latter. Imagine an assembly of men who are supposed to deliberate and work together : one third can speak but English, another third can speak but Latin, and the rest are versed in both languages. Would it not be wiser (*ceteris paribus*) to select the leaders in the third group ? I give this comparison *faute de mieux*, but it is unsatisfactory, for it is far easier to translate from one language into another than to impart a scientific attitude to one who has no scientific experience. The encyclopaedic training would be the ideal one for a college president and for any man whose scientific duties are not specialized.

VII

The organization of courses on the history of science like those I am dreaming of — not introductory, but rather retrospective —

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an optimal size, beyond which it can not remain a *live* institution. But this abnormal growth is itself a symptom of industrialism. With the exception of a very few colleges (notably Princeton, Dartmouth, Bryn Mawr) the proportion of applicants who are refused admission is exceedingly small. It would benefit the Great Republic more to have fewer students and better universities. (Conclusions based upon figures published in the *New York Times* of Oct. 16, 1921).

would have far-reaching consequences. It would be the wedge by means of which encyclopaedic studies and the encyclopaedic point of view would gradually penetrate into our universities. It is partly because of this that I insist so much upon the history of science as against the histories of particular sciences. Such special histories are, to be sure, interesting enough, and their study should be encouraged to insure a deeper understanding of the science concerned; indeed, from the purely scientific point of view their interest is very great, but none of them can possibly have the same educational, humanistic bearing as the history of science. The progress of civilization is a function of the growth of knowledge in general, not of any special kind in particular. Besides, the evolution of each science is dependent in many ways upon the advance made by the others.

From this point of view, it should be remarked that the teaching of the history of science will not be simply one more teaching added to so many others, but will have a synthetic and coördinating value the importance of which can not be overestimated. Of course, this synthetic value will depend very much upon the personality of the teacher. But I am so convinced of its importance that I would fain say that the teaching of the history of science must be of a synthetic nature, or else that it does not deserve to exist.

But that is not all. The whole historical teaching will be gradually influenced by the history of science. Even if it be found expedient to leave to elementary teaching a purely political and pathological character (that is, if, as I now believe it, it is thought best to paint the background first), even then historians will be gradually impressed with the need of a scientific training. They will cease to be purely men of letters; driven between the archaeologists on the one side, and the historians of science on the other, their traditional ignorance of science will no longer be for them a matter of jest or boast, but a matter of shame. We have already attended a similar evolution with regard to geography. When I was a child, teachers of geography were literary men; their transformation into scientists has taken place so rapidly that before long a literary geographer will be as rare as the dodo. It is now generally understood that a sound knowledge of the structure of the earth, and of the soil, the meteorological conditions, the minerals, the plants and animals of each climate, is the natural introduction to geographical studies. That is, geology, meteorology and natural history are now considered as the

foundation of geography. Before the end of this century it will seem equally obvious that only those who are able to understand the elements of human progress are entitled to teach its history. The historical seminaries will then contain laboratories and small collections of natural history (as mementos!) and it will be recognized that for the average historian some knowledge of science is far more essential than a knowledge of heraldry or sigillography : the necessity of scientific propaedeutics will be generally accepted.

A good example of such preparation was given a long time ago by my dear master, EDWARD GIBBON. I quote from his autobiography this most interesting fragment (1) :

« After a short holiday, I indulged my curiosity in some studies of a very different nature, a course of Anatomy which was demonstrated by Dr. HUNTER, and some lessons of Chemistry which were delivered by Mr. HIGGINS : the principles of these sciences, and a taste for books of Natural History, contributed to multiply my ideas and images, and the Anatomist or Chemist may sometimes track me in their own snow. »

GIBBON did not pursue his scientific studies beyond this preliminary stage, yet he had clearly understood their importance, and scientists will have now one reason the more (if they did not know of it) for admiring him. If all historians took as much pains to approach the scientific point of view as GIBBON did, there would be less ground for complaining of their onesidedness, and the chasm between them and the scientists would not be quite as deep as it is.

The history of science will be the channel through which science will gradually penetrate into a system of education from which it has been thus far jealously excluded. It is through it that the humanizing value of science will first be felt. But well may the conservative hesitate to introduce it into the curriculum, for it will slowly but surely call forth a radical transformation of the whole system, a transmutation of educational values. The historians of science will constitute the vanguard of the New Humanism.

Cambridge, Massachusetts,
October 1921.

GEORGE SARTON.

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Revised in Haskins, Studies 272

Michael Scot and Frederick II

In any judgment respecting the scientific activity of the court of Frederick II, much depends upon the opinion formed of Michael Scot, the emperor's astrologer, whose writings form a large part of the scientific and philosophic product of the *Magna Curia.* Condemned by Roger Bacon as « ignorant of the sciences and languages », Scot is praised by Gregory IX for his knowledge of Hebrew and Arabic, and addressed as *summe philosophe* by Leonardo Pisano, the most eminent mathematical genius of his time. Naturally enough for an astrologer, Scot early became a subject of legend, and the small body of fragmentary fact has not yet been winnowed from the mass of tradition. The elaborate biography by Dr. J. Wood Brown (1) contains far too much of pleasing conjecture, and its insecure chronology has misled more than one subsequent writer. It may help investigation if we try to set down the ascertainable events of Scot's life and to group his works in some chronological order, as a preliminary to an examination of his treatises on astrology and his intellectual relations with the emperor.

Concerning the place and date of Scot's birth no evidence has reached us. We may, however, be sure that when Master Michael calls himself Scot (2) he means a native of Scotland and not an Irishman, as the name frequently signifies in mediaeval usage. Not only did he hold benefices in Scotland (3), but he refused a most lucrative appointment, the archbishopric of Cashel, because he was ignorant of the Irish tongue (4). That he knew English appears

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(1) *An Enquiry into the Life and Legend of* Michael Scot (Edinburgh, 1897); followed closely in the article in the *Dictionary of National Biography.*

(2) « Cui ego Michel Scottus tanquam scottatus a multis et a diversis » : Bodleian. MS. Canon. Misc. 555, f. 45; infra p. 270. « Ego Michael Scotus » : Jourdain, *Recherches sur les traductions latines d'*Aristote (Paris, 1843), p. 127-129; MS. Pisa 11, on p. 252, below.

(3) Bliss, *Calendar of Papal Letters,* I, p. 102.

(4) *Ib.*, I, p. 98.

from a list of Anglo-Saxon names of months which he inserts in his *Liber introductorius* (1). The facts of his career place his birth somewhere in the late years of the twelfth century. Of his education we know nothing, the statements concerning his studies at Durham, Oxford, Bologna and Paris being mere guesses of modern writers. All that we can say is that his writings show a knowledge of the elements of Latin culture — the Bible, AUGUSTINE, the writers on the *trivium* and *quadrivium* — and that this was probably gained before he went to Spain for more special studies.

We must likewise dismiss as entirely baseless Dr. BROWN's chapter which makes SCOT tutor of the young FREDERICK II and author of various works composed in Sicily in 1209 and 1210. The sole foundation for this elaborate construction is the misreading as « MCCX » of the « MCC etc. » of a Vatican codex of the *Abbreviatio* AVICENNE (2); and there is no evidence connecting SCOT with Sicily until many years later.

The first specific date in SCOT's career is 18 August 1217, when he completed at Toledo his translation of AL-BITRODJI (ALPETRAGIUS) *On the Sphere* (3). He had plainly been for some time in Spain and

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(1) *Nomina mensium secundum Anglicos.* Primus mensis anni Anglorum est giuli, id est januarius; 2. est solmonant, id est februarius; 3, est heredemonath, id est martius; 4. est turimonath, id est aprilis; 5. est thrumiei, id est maius; 6. est lidan; 7. est lydi; 8. est vendmonath; 9 est aligmonanh; 10. est gyh. Hee gentes suum annum incipiunt a medianocte nativitatis Domini et quociens sunt kalende mensium tociens solempne pulsant campanas ecclesie maiori post complementum officii matutini cum interpollatione et omnes gentes summa devocione vadunt ad eandem ecclesiam portantes aliquid ad offerendum. Cod. Lat. Monacensis 10268, f. 71v.

(2) See the facsimile in BROWN, p. 55. Monsignore AUGUST PELZER of the Vatican Library informs me, as I had conjectured from the facsimile, that « MCC etc. » is the necessary reading of the original. I find that Sir JOHN SANDYS had also questioned BROWN's reading, but without rejecting the inferences from it (*History of Classical Scholarship*, third edition, I, p. 566).

(3) JOURDAIN, *Recherches*, p. 133, where one MS. has the Christian and one the Spanish era. This is confirmed by MS. Madrid 10053 (ca. 1300, formerly in the chapter library at Toledo), f. 156v. : « Perfectus est liber AVENAL. AVENALPETRAUG a magistro MICHAELE SCOTTO Toleti in decimo octavo die veneris augusti hora tertia cum ABUTEO levite anno incarnationis Jesu Christi 1217 ». MS. BARBERINI Lat. 156 of the Vatican, f. 194, has 1221, but with the same day of the week and month. STEINSCHNEIDER, in Vienna *Sitzungsberichte*, CXLIX, p. 57 (1904), gives incorrectly 1267. Cf. MS. ARSENAL, 1035.

gained something of that acquaintance with Arabic which was to serve him later. The next point in Scot's biography is 21 October 1220, when he appears at Bologna, living in the house of the widow of Alberto Gallo and giving a medical consultation on a neighbor's case of calculus (1). The sworn note to this effect which he appends to certain copies of the *De animalibus* gives the year as 1221, but the day of the week given shows that he is using the Pisan style, as in his later works (2). This is his first appearance in Italy, and it should be remarked that Frederick II was in the neighborhood of Bologna at the same time (3), although we have no evidence that Scot was then in the emperor's service.

From 1224 to 1227 the papal registers show that Scot had the active favor of Pope Honorius III and his successor, Gregory IX. This interesting series of entries begins 16 January 1224 with a letter from Honorius III recommending Scot to the archbishop of Canterbury as a man of eminent learning (*singularis scientia inter alios litteratos*), worthy of a benefice in that province (4). The church assigned yielded an insufficient income, and 18 March he received permission to hold two benefices (5), one of which appears from what follows to have been in England. His tenure of these was unaffected by his elevation the following May to the archbishopric of Cashel (6), but by 20 June he had declined this preferment because of his ignorance of Irish (7). 9 May 1225 he is allowed to hold an additional benefice in England and two in Scotland (8). 28 April 1227 Gregory IX, shortly after his accession, urges Michael's claims on the archbishop of

(1) The note is printed by Dr. M. R. James in the *Catalogue of the Manuscripts in the Library of* Gonville *and* Caius *College*, I, p. 112, from MS. 109. It is also found in a XIIIth century copy of the *De animalibus* in the manuscripts of the Convento S. Caterina at Pisa, MS. 11, f. 133-133v (cf. *Studi italiani di filologia classica*, VIII, p. 325), where the following is added to Dr. James' text : « eiecit in octabis sancti Johannis maiorem post. VIII. dies post minorem. »

(2) Below, p. 266.

(3) Böhmer-Ficker, *Regesta Imperii*, Nos. 1176-1194.

(4) Pressutti, *Regesta Honorii Pape* III, No. 4682; *Chartularium Universitatis Parisiensis*, I, No. 48; Brown, p. 275; Bliss, *Calendar of Papal Letters*, I, p. 94.

(5) Pressutti, No. 4871; Bliss, I, p. 96.

(6) Pressutti, No. 5025; not in Bliss.

(7) Pressutti, No. 5052; Bliss, I, p. 98.

(8) Pressutti, No. 5470; Bliss, I, p. 102.

Canterbury as one who had pursued learning since boyhood and added a knowledge of Hebrew and Arabic to his wide familiarity with Latin learning (1).

In 1228, or, since we are in Pisa, more probably in 1227, falls the dedication to SCOT of the revised edition of the great treatise of LEONARDO PISANO on the abacus, of which SCOT had solicited a copy from the author (2). As LEONARDO was in relations with FREDERICK II and the philosophers of his entourage as early as 1225 or 1226 (3), SCOT may have already become connected with the emperor's court. In any event, SCOT disappears from the papal registers after 28 April 1227 and no long time can have elapsed before he joined the court of FREDERICK II with which he is thereafter identified. Contemporaries call him FREDERICK's astrologer and recount various stories of his skill, even to the prediction of the place of the emperor's death (4), while SCOT himself mentions instances of his prophesying from the stars the results of FREDERICK's military operations (5). SCOT's later works are dedicated to the emperor, and one of them, the *Abbreviatio* AVICENNE, was kept in the emperor's library in 1232. The loss of the imperial registers, save for a fragment of 1239-1240, prevents our tracing details of his activity at the court, except for some indications in SCOT's own writings to which we shall come below.

If we could accept the statement of a note which accompanies this prophecy in one manuscript, SCOT was at Bologna in 1231, where he was consulted by the *podestà* and notables concerning the fate of the Lombard cities and replied with a famous set of verses predicting the fate of each. The references to the events of 1236 and following are,

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(1) AUVRAY, *Régestes de* GRÉGOIRE IX, No. 61; *Chartularium Universitatis Parisiensis*, I, No. 54; POTTHAST, *Regesta*, No. 7888; BLISS, I, p. 117.

(2) BONCOMPAGNI, *Scritti di Leonardo Pisano* (Rome, 1857), I. p. 1; for the date 1228, see BONCOMPAGNI in *Atti dei Lincei*, first series, V, p. 73 f. (1851); CANTOR, *Vorlesungen über die Geschichte der Mathematik*, II, p. 7.

(3) *Scritti*, II, p. 253. On the chronological difficulties, see ENESTRÖM, in *Bibliotheca Mathematica*, IX, 72f. (1908).

(4) SALIMBENE, ed. HOLDER-EGGER, p. 353, 361, 512, 530; RICCOBALDI of Ferrara, in MURATORI, *Scriptores*, IX, col. 128; FRANCESCO PIPINI, *ib.*, IX, coll. 660, 670.

(5) « Et ut apercius hec dicta pateant, recordamur duarum questionum inter alias principis volentis ire super duas civitates sibi rebelles », followed by the observations, with diagrams, and SCOT's deductions. *Liber introductorius*, MS. n. a. Lat. 1401, f. 99v.

however, so specific as to indicate that this *Vaticinium* was written subsequently and ascribed to Scot (1), who was known to have made definite predictions foretelling the emperor's triumph over his enemies (2).

The date of Scot's own death is apparently fixed by certain verses of Henry of Avranches dedicated to the emperor shortly before his last return to Italy from Germany early in 1236 (3). Scot is here mentioned as one who has passed, apparently recently, into eternal silence, and there is no reason to doubt the testimony of a court poet then in the emperor's following. If we attach any weight to the Paris manuscript of Scot's *Vaticinium*, he was in Germany with the emperor on this journey, and would thus have met his death there (4). The story ran that he was killed at mass by the falling of a stone, in spite of a metal headpiece by which he had sought to protect himself (5).

The only reason for seeking to place Scot's death later is connected with the dates of his writings. The manuscripts of his *Liber particularis* bear a title *tempore domini pape* Innocentii *quarti* (1243-1254), and since the preface refers to an event of 1228 this cannot be explained away by Brown as a slip for Innocent III; but, as there is no reference to this pope in the text, we may have no more than the guess of a scribe, itself inconsistent with a closing verse of 1256 (6). The commentary on the *Sphere* of John of Sacrobosco must be subsequent to the date of that work, often stated as 1256, but the facts of Sacrobosco's life have not been sufficiently investigated, and Scot's authorship is too uncertain to permit drawing any decisive conclusion.

Scot's writings are, with one exception, undated in the form in

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(1) Holder-Egger, in *Neues Archiv*, XXX, p. 349-377, where the text of the verses appears as well as in his edition of Salimbene, p. 361. Cf. Winkelmann, *Kaiser* Friedrich II, II, p. 323, n. A note in MS. lat. n. a. 1401, f. 124v., not used by Holder-Egger, states that the verses were recited to the emperor by Scot before the departure from Germany : Delisle, *Catalogue du fonds de* La Trémoïlle, p. 43.

(2) Poem of Henry of Avranches : *Forschungen zur deutschen Geschichte*, XVIII, p. 486.

(3) *Ibid.*

(4) *Catalogue du fonds de* La Trémoïlle, p. 43, cited above.

(5) Pipini, in Muratori, IX, col. 670.

(6) This verse is also found in the *Vaticinium* of John of Toledo : *Neues Archiv*, XXX, p. 353, note.

which they have reached us. They can, however, be distinguished into two main groups, corresponding to the two chief periods of his activity, the Spanish and the Sicilian. Speaking broadly, natural philosophy predominates in the earlier period, and astrology in the later. Let us consider them in this order :

(1) The only dated work is the translation of AL-BITRODJI, completed at Toledo 18 August 1217. This treatise, which develops ARISTOTLE's theory of homocentric spheres against the eccentrics and epicycles of PTOLEMY, was of considerable importance as a source of Aristotelian cosmology in the thirteenth century, and SCOT's version seems to have been the medium through which it was known to ROGER BACON and others (1).

SCOT's version of ARISTOTLE's *Historia animalium* is in three of the manuscripts dated at Toledo (2). His authorship is clear from a memorandum inserted in his own copy and preserved in two extant manuscripts (3). This note, dated at Bologna 21 October 1220, shows that the work must have been completed before this date, and thus strengthens the statement that this version belongs to the Toletan period of SCOT's life. As the manuscripts lack a dedication, the words *at Caesarem* added in current usage would appear to rest on a confusion with the *Abbreviatio* AVICENNE. Whether the translation was made from the Hebrew or from the Arabic has been a matter of dispute (4); in any event à Jewish interpreter (5) seems to have been used. The version is closely literal, so that it has even been used for reconstructing the Greek original (6); but there are also numerous errors, which were repeated by ALBERTUS MAGNUS in using it (7). Here, as in the usual Arabic tradition of the work, the *Historia*

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(1) For the date and manuscripts, see above, p. 251 ; for the contents, P. DUHEM, *Le système du monde* (Paris, 1914), III, p. 241 ff. 327f.

(2) MERTON College, MS. 278; Cues, MS. 182 (GRABMANN, *Aristotelesübersetzungen*, p. 187); Laurentian, Plut. XIII, sin., cod. 9 (BANDINI, IV, p. 109).

(3) See above, p. 252, note.

(4) See especially WÜSTENFELD, in *Abhandlungen* of the Göttingen Academy, XXII, p. 101-106 (1877); STEINSCHNEIDER, *Die hebräischen Uebersetzungen des Mittelalters* (Berlin, 1893), p. 479-483.

(5) ROGER BACON, *Compendium Studii*, ed. BREWER, p. 472.

(6) RUDBERG, in *Eranos*, IX, p. 92ff.

(7) H. STADLER, *Albertus Magnus de animalibus* (Münster, 1916), I, p. XII; Id., in *Archiv für die Geschichte der Naturwissenschaften*, VI, p. 387-393 (1913).

animalium consists of nineteen books, including not only the *De animalibus historia*, with the spurious tenth book, but the *De partibus animalium* and the *De generatione animalium*. For all of these Scot's version was the first and remained in use till the fifteenth century (1).

In the case of other works of Aristotle the question is complicated by the fact that there was more than one version from the Arabic in circulation in the thirteenth century, as well as by their relation to the accompanying commentary of Averroes. The one entirely clear case is the *De cœlo et mundo*, to which Scot has prefixed a preface addressed to Stephen of Provins, a French ecclesiastic who is found in various documents between 1211 and 1231, in which year he is named by Gregory IX as one of the commission to examine and purge the newly translated works of Aristotle on natural science (2). This version is subsequent to 1217, as it cites the translation of al-Bitrodji. It is altogether likely that Scot is the author of the version of the *De anima* which, with the commentary of Averroes, regularly accompanies his *De cœlo* in the manuscripts (3). Translations of the *Physics*, *Metaphysics*, and *Ethics* have been ascribed to Scot, but without sufficient evidence (4). The argument is somewhat stronger for certain other commentaries of Averroes, coinciding as they do with Scot's *Questiones* Nicolai (5), but the matter is not yet clear. In any event Scot's role was merely that of translator; it was Averroes, *che il gran commento feo* (6)!

Two philosophic treatises of Scot probably belong to the Spanish

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(1) See in general, Grabmann, *Forschungen über die lateinischen Aristotelesübersetzungen des XIII. Jahrhunderts* (Münster, 1916), p. 185-187, and the literature there cited. This version passed quickly into use. Before Albertus Magnus we find it cited by Philip de Grève, 1228-1236 (Menges, in *Philosophisches Jahrbuch*, XXVII, p. 28); and by Bartholomew Anglicus, *ca.* 1240 (Grabmann, p. 42).

(2) Jourdain, p. 127*f.*; Grabmann, p. 175; Renan, Averroès (Paris, 1869), p. 206; bull of Gregory in *Chartularium Universitatis Parisiensis*, I, No. 87. Another manuscript is at Erfurt, F. 351.

(3) Hauréau, *Philosophie scolastique* (1880), II, 1, p. 125; Grabmann p. 198.

(4) Jourdain, p. 128, 141*f.*, 144; Grabmann, p. 172, 212, 215, 217. Note that the *Ethics* is cited in the preface to the *Liber introductorius* (see below), and the *Metaphysics* in the Commentary on Sacrobosco.

(5) Renan, Averroès, p. 205.

(6) Dante, *Inferno*, IV, line 144.

period. One, a *Divisio philosophica*, or classification of philosophical knowledge, preserved only in fragments by VINCENT OF BEAUVAIS, is based in considerable measure upon DOMINICUS GUNDISALVI, who worked in Spain in the XIIth century (1). The other, known in extracts as the *Questiones* NICOLAI *peripatetici*, is definitely assigned by ALBERTUS MAGNUS to SCOT (2), who here seems to take shelter in anonymity in order to preach strong Averroism (3).

(II) From the Sicilian period of SCOT's activity we have, first of all, the *Abbreviatio* AVICENNE *de animalibus*, dedicated to FREDERICK II as emperor. We have already seen that this cannot be dated 1210 (4), as BROWN fondly thought; all that we can say is that it was anterior, and probably not long anterior, to the copy made from the emperor's original by HENRY OF COLOGNE at Melfi 9 August 1232 (5). FREDERICK's keen interest in animals, and especially in birds, is a sufficient explanation of its origin (6).

The most ambitious of SCOT's works belong to this period, the series of treatises on astrology made up of the *Liber introductorius*, the *Liber particularis*, and the *Physiognomia*. In their final form these are subsequent to 16 July 1228, since the general preface refers to FRANCIS OF ASSISI as already a saint (7). They are dedicated to the emperor, whom they mention in the text, and, as we shall see, contain in part answers to specific questions asked by him.

(III) The remaining works attributed to SCOT are more or less doubtful. The court of FREDERICK II became a peg on which to hang

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(1) BAUR, DOMINICUS GUNDISSALINUS *De divisione philosophiae* (Münster, 1903), p. 364-367, 398-400.

(2) « Feda dicta inveniuntur in libro illo qui dicitur *Questiones* NICOLAI *peripatetici*. Consuevi dicere quod NICOLAUS non fecit librum illum sed MICHAEL SCOTUS, qui in rei veritate nescivit naturas nec bene intellexit libros Aristotilis. » *Opera* (ed. Paris, 1890), IV, p. 697.

(3) HAURÉAU, *Philosophie scolastique* (1880), II, 1, p. 127; RENAN, AVERROÈS, p. 209f.; DUHEM, *Le système du monde*, III, p. 245f., 339, 346f.

(4) *Supra*, p. 251.

(5) HUILLARD-BRÉHOLLES, *Historia diplomatica*, IV, p. 381.

(6) See my study of FREDERICK'S *De arte venandi cum avibus*, in *English Historical Review*, July, 1921.

(7) « Quandoque sine vestibus cum alis, ut seraphim ad beatum FRANCISCUM et MICHAEL quando pugnavit cum dracone et quando consignavit in Monte Gargano ecclesiam, propter quod dicitur Mons Angeli qui est prope Romam versus Apuliam ». Munich, Cod. lat. 10268, f. 9v; N. a. lat. 1401, f. 22, omitting what follows « ecclesiam ».

all sorts of fictitious attributions (1), and Scot's popular reputation could easily lead to connecting his name with the works of others. Such false ascriptions are particularly frequent in the alchemical literature of the XIIIth and XIVth centuries, and until this has been more carefully sifted, it is safer to reserve the question of the specific alchemical writings which bear Scot's name (2). It is altogether likely that they have a genuine nucleus, indicated by the mention of Scot and Friar Elias in the text of the Corpus manuscript and by the knowledge of alchemy displayed in the passage from the *Liber particularis* printed below.

The commentary on the *Sphera* of John of Holywood has already been mentioned apropos of the date of Scot's death. No manuscript has been cited, and the only basis for ascribing it to Scot is the title of the printed edition (3). The preface shows some similarities of phrase to the preface to the *De arte venandi* of Frederick II (4), and the commentary recalls al-Bitrodji (5); but there are no references to the emperor in the body of the work, and the scholastic style is quite unlike that of Scot's astrological writings, which are, indeed professedly popular. The treatise on geomancy ascribed to Scot in a

(1) Ch. V. Langlois, *La connaissance de la nature et du monde au moyen âge* (Paris, 1911), p. 190-192.

(2) Brown, c. 4. E. von Lippmann, *Entstehung und Ausbreitung der Alchemie* (Berlin, 1919), does not discuss Scot's alchemical writings, but only (p. 514, 680) his illustrations of the planets.

(3) « Eximii atque excellentissimi physicorum motuum cursusque syderei indagatoris Michaelis Scoti super auctorem sperae cum questionibus diligenter emendatis incipit expositio confecta Illustrissimi Imperatoris Dni. D. Federici precibus ». I have used the Bologna edition of 1495 (Hain, 14555) in the Thatcher collection in the Library of Congress.

(4) « Causa efficiens est magister Johannes de Sacrobusto et alii compositores. Causa finalis cognitio corporum celestium in se et proprietatum . . . . . modus agendi est quintuplex, scilicet definitivus, probativus, id est probatitius, exemplorum positivus, ut legitime per se liqueat ». *Ib.*, f. 1v. So Frederick considers *intentio*, *utilitas*, and describes the *modus agendi* as « prosaycus, prohemialis, et executivus, executivus vero multiplex, partim namque divisivus, partim descriptivus, partim convenientiarum et differentiarum assignativus, partim causarum inquisitivus ». Vatican, MS. Pal. lat. 1071, f. 1v. The preface to Scot's *Liber introductorius* discusses *ars*, *genus*, *intentio*, *utilitas*, *finis*, *instrumenta*, etc. Clm. 10268, f. 16v; N. a. lat. 1401, f. 35. That of the *Liber luminis luminum* (Brown, p. 81, 240) has *intentio*, *causa intentionis*, *utilitas*.

(5) Duhem, III, p. 246-248, who accepts Scot's authorship.

late Munich manuscript is very doubtful (1), and the *Mensa philosophica*, at times attributed to him (2), is clearly by another and later hand.

Scot's translations were the occasion of unfavourable judgments on the part of Roger Bacon, who declared that Scot did not really know the languages or the sciences, and that the work was chiefly done by a Jew named Andrew (3). Help of this sort was usually employed by the Toletan translators (4); whether Michael was more inaccurate than others is a question which has not been investigated (5). On the other hand Bacon seems to ascribe too much credit to Scot as the introducer of the natural philosophy of Aristotle (6), for, as we have seen, only one of these treatises, the *De animalibus*, was first given to the Latin world by Scot. Bacon's date 1230 has likewise been taken too literally, especially by those who have sought to connect it with the letter recommending the new versions of Aristotle to the universities, a document once ascribed to Frederick II but now generally admitted to come from Manfred, and to relate to the translations made at his court (7).

In general Scot's writings show a respectable education. He quotes the Scriptures freely and refers occasionally to Augustine and Ambrose and more frequently to Boethius, Isidore and Bede. Classical Latin writers, such as Virgil, Cicero, and Ovid, rarely appear. The citations from Aristotle are fairly numerous; besides the *Meteora* and *De caelo* they include two references to the full text of the *Ethics*, then just coming into use in the West (8). There is

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(1) Cod. lat. 489, ff. 174-206v (sæc. xvi) : *Liber geomantiae* Michaelis Scoti.

(2) As by Querfeld, p. 12.

(3) *Compendium Studii*, ed. Brewer, p. 472; *Opus Tertium*, ed. Brewer, p. 91.

(4) Rose, in *Hermes*, VIII, p 332ff.

(5) Save in the case of the *De animalibus*; supra, p. 255.

(6) « A tempore Michaelis Scoti qui annis Domini 1230 transactis apparuit deferens librorum Aristotilis partes aliquas de naturalibus et metaphysicis cum expositionibus authenticis magnificata est philosophia Aristotilis apud Latinos. » *Opus Majus*, ed. Bridgets, I, p. 55, III, p. 66.

(7) Document in Huillard-Bréholles, *Historia diplomatica*, IV, p. 383; *Chartularium Universitatis Parisiensis*, I, No. 394. *Cf.* Böhmer-Ficker, *Regesta*, No. 4750; Grabmann, p. 201-203, 237, 249.

(8) « Ethica est scientia moralis quam reperitur conpillavisse Aristotiles, cuius liber sic intitulatur, Ethicorum Nichomachiorum Aristotiles liber primus

no evidence of any real knowledge of Greek, the etymologies and the Greek names of months, climates, and points of compass being easily available at second hand; indeed it has been pointed out that in mentioning specifically Scot's knowledge of Hebrew and Arabic, Gregory IX would hardly have omitted Greek if Scot had known this language. The extent of Scot's knowledge of Hebrew we are unable to judge, but he seems to have been in relations with Jacob Anatoli, the translator of Averroes and Ptolemy (1). It may also be noted that the Arabic writers on astronomy and astrology whom Scot cites freely were in large part available in Latin versions of the twelfth century. His scientific writings show a knowledge of medicine (2), natural philosophy, and music, as well as a familiarity with the various branches of astronomy and its mediaeval applications. They deserve a closer examination than can here be given in relation to the astronomy and cosmology of his age.

Scot's writings on astrology were the basis of his literary fame in the Middle Ages, and it is by these that his scientific attainments must chiefly be judged today. The three treatises are introduced by a general preface, which he also calls an epilogue and which was hence written after the completion of the series (3). It is here clear that the three are parts of a single comprehensive work, and cross-references are frequent between the *Liber introductorius* and the *Liber particularis*. This general preface, which is long and diffuse, occupying thirty-eight pages in the principal manuscript, is largely given up to a loose discussion of the Creation — in the course of which the Averroistic doctrine of the eternity of the universe is

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incipit; et sunt 10. libri cuius primus ita incipit, Omnis ars et omnis doctrina, etc. » Clm. 10268, f. 18v; N. a. lat. 1401, f. 37. « Unde Aristotiles in libro Ethicorum : desideratur res propter aliud. » Cod. lat. Mon. 10268. f. 16; MS. lat. n. a. 1401, f. 33v. The history of the Latin versions of the *Ethics* is treated by Pelzer in the *Revue néo-scolastique* for 1921, p. 316-341, 378-400.

(1) Renan, in *Histoire littéraire*, XXVII, p. 580-589; Steinschneider, *Hebräische Uebersetzungen*, p. 58, 61, 523, 553. On contemporary Jewish culture in Sicily see further M. Güdemann, *Geschichte des Erziehungswesens der Juden in Italien* (Vienna, 1884), p. 101-107; R. Straus, *Die Juden im Königreich Sizilien* (Heidelberg, 1910), p. 79-91.

(2) Cf. also the prescriptions which passed under his name : Brown, p. 154f.

(3) Munich, cod. lat. 10268, ff. 1-19v; Bibliothèque Nationale, MS. n. a. lat. 1401, ff. 11-39; Edinburgh, MS. 132, f. 34. Cf. Boll, *Sphära*, p. 440, n.

specifically denied (1) — God, the Trinity, the nature of man, and the various orders of angels and evil spirits. The heavenly bodies are not the cause of the events which they indicate, but only the signs, as the circle before the tavern is only the sign of the wine within (2); but, granted an accurate knowledge of planets and the zodiac, we may know future events and the right occasions for doing anything (3). Indeed, we are later told that the astrologer need not err, by God's help (4). Sound learning (*mathesis*) is carefully distinguished from those magic arts (*matesis*) (5), which no Christian can rightly practise — geomancy, hydromancy, aeromancy, pyromancy, spatulamancy, necromancy, divination, auguries, incantations, prestigiation, etc. The examples show that SCOT was not unacquainted with these arts, as when, in the name of the Trinity, he gives an incantation for summoning the spirit FLORIGET (6). The list of magicians includes SIMON MAGUS, VIRGIL, PETER ALEXANDRINUS, the *ariolus* of ALEXANDER, and PETER ABELARD; to whom he elsewhere (7) adds SOLOMON and OTTONEL OF PARMA. The history of astrology is traced from ZOROASTER to GERBERT, via NIMROD, whose dialogue with IOANTON, illustrated with circles and figures, SCOT has evidently seen and indeed uses in the body of the *Liber particularis* (8). From Egypt, where it was elaborated by King PTOLEMY, astronomical knowledge was carried to Spain by ATLAS, all before the birth of MOSES, and from ATLAS two French clerks brought the knowledge of the astrolabe in France to GERBERT, *optimus negrimanticus*, who by diabolical arts attained the archbishopries of Reims and Ravenna and at last the papal see.

The last of the three treatises, the *Physiognomia*, may be dismissed

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(1) « Ob hanc causam dicunt multi quod mundus sit ab eterno... et quod non sit mundus eternus patet aperte. » Clm., f. 1v; Nal., f. 11v. Cf. the commentary on SACROBOSCO, f. 2.

(2) Clm., f. 1; Nal., f. 11v.

(3) Clm., f. 15; Nal., f. 32v.

(4) Clm., f. 118v.

(5) *Ib.*, ff. 17-17v. So ROGER BACON, as in the *Secretum secretorum* (ed. STEELE), p. XXVIII, 2f.

(6) Clm., f. 114v; not in Nal.

(7) Clm., f. 114v.

(8) See my article, « NIMROD the Astronomer », in the *Romanic Review*, V, p. 203-212 (1914). The figures of the Venetian manuscript deserve study; cf. p. 263, note 4 below.

with a word, as it has long been accessible in print and has been studied by FOERSTER (1) and more recently by one of SUDHOFF'S pupils, A. H. QUERFELD (2). Dedicated to the emperor, whom it professes to guide in his judgments of men, it contains a treatise on generation and an account of the prognostications from dreams, complexions, and the different parts of the body. Its indebtedness to the *Physiognomy* of the Pseudo-Aristotle is limited to the preface; it makes free use of RAZI, and shows some affinities with TROTULA and other SALERNITAN writers (3). There is also, possibly through a common Arabic source, some connection with the contemporary Latin version of the Pseudo-Aristotelian *Secretum secretorum* (4). The *Physiognomia* was much the most popular work of SCOT, having been printed in a score of incunabula and nearly as many later editions (5).

The *Liber introductorius*, consisting of four parts or distinctions, is SCOT'S most ambitious work (6). It is written in more or less

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(1) *De translatione latina Physiognomicorum quae feruntur* ARISTOTELIS (Kiel, 1884): *De* ARISTOTELIS *quae feruntur Secretis Secretorum* (Kiel, 1888); *Scriptores Physiognomici* (TEUBNER ed., 1893).

(2) MICHAEL SCOTTUS und seine Schrift *De secretis naturae* (Leipzig diss., 1919).

(3) FÖRSTER, *Scriptores*, p. XXIII-XXV, CLXXIX; QUERFELD, p. 20-23, 26.

(4) FÖRSTER, *Scriptores*, p. CLXXIX; ROGER BACON'S *Secretum Secretorum*, ed. STEELE (Oxford, 1920), p. XVIII-XXI, LXIII.

(5) QUERFELD, p. 14 f., who has also used the AMBROSIAN manuscript of 1256. I have used still another printed copy in the Harvard library, ca. 1490 (REICHLING, No. 1864), which is omitted from the *Census of Fifteenth Century Books owned in America*. The printed text lacks the chapters on urine, also copied as a separate treatise, which QUERFELD prints, p. 50-60; Italian version at Naples, Biblioteca Nazionale, MS. XV, F. 51.

(6) Munich, cod. lat. 10268, 146 folii, with notable figures, XIVth century; Oxford, MS. BODLEY 266, a copy of the Munich manuscript (BOLL, *Sphæra*, p. 444); Paris, Bibliothèque Nationale, Nouv. acq. lat. 1401, ff. 39, 128v, probably copied in 1279 (DELISLE, *Catalogue du fonds de* LA TRÉMOÏLLE, p 41-43); Escorial, MS. f. III, 8; modern copy at Munich, cod. lat. 10663. Extracts at the University of Edinburgh, MS. 132 (= Munich MS., ff. 118-146v); Bibliothèque Nationale, MS. lat. 14070, ff 112-118v (= Munich, ff. 86v-89v); Vienna, MS. lat. 3124, ff. 206-211, MS. 3394, f. 214 ff. (SAXL, in *Der Islam*, III, p. 166); Vatican, MS. Pal. lat. 1363, ff. 90-94; MS. Pal. lat. 1370 (SAXL, in Heidelberg *Sitzungsberichte*, 1915, p. 25); MS. Vat. lat. 4087, ff. 88-99v; see also BROWN, p. 27.

None of these manuscripts seems complete. The Munich and Oxford codices lack the fourth distinction which cross-references show to have contained chapters

popular fashion (*leviter*) for beginners in the art of astrology (1), but is also intended for the convenience of adepts who may not have at hand the many works to which the author refers. It is not well organized, but the early portions are chiefly astronomical and the later astrological, the various heavenly bodies being taken up one by one and detailed advice given for the practice of the astrological art. The calendar is treated at some length, and there is a certain amount of meteorology, developed more fully in the *Liber particularis*. Emphasis is laid on the mystical value of the sevens which rule the world — seven planets, metals, arts, colors, odors, tones, etc. The music of the spheres leads to a digression on music, *de notitia totius artis musice*, which gives an outline of the whole subject, with citations of BOETHUS and GUIDO (2). The astronomy is based chiefly on AL-FARGANI, with occasional citation of the *Almagest* (3), but the remarkable figures of the constellations and planets in the Munich and Oxford manuscripts represent an antique tradition which is ascribed by BOLL to the *scholia* of Germanicus (4). SCOT uses the Toletan tables, though he knows those of Arin and others. The astro-

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De anima (Munich, MS. ff. 15, 88v), *De arte cyromantie*, and *De elementis* (MS. Canon. Misc. 555, f. 37-37v); they also contain later additions, as a table of 1320 (Munich, f. 76v) and a judgment of BARTHOLOMEW OF PARMA in 1287 (f. 125v). The Paris copy is earlier and considerably briefer, but includes the fourth distinction (ff. 105v ff., where the elements and the soul are treated). It ends (f. 128v): « Librum primum in arte astronomica incepimus in honore et laude Dei et ad preces domini nostri FREDERICI Rome imperatoris et semper augusti leviter composuimus propter novicios in arte et pauperes intellectus, et nunc ipsum complevimus suo adiutorio cui sit dignus honor, grandis laus cum actionibus gratiarum, concors amor, una fides, rectus timor, et reverens obedentia cum omni supplicatione humilitatis in preceptis eius per nos et sequentes amen, amen. » The Munich manuscript ends merely: « Expliciunt iudicia questionum hominum secundum sententiam MICHAELIS SCOTTI grandis astrologi condam imperatoris FREDERICI de terra Teotonica, Deo gratias amen. »

I have used the Munich manuscript, cited as Clm., of which I have a complete rotograph, and the Paris manuscript, cited as Nal.

(1) Clm., f. 30; cf. ff. 74, 100, and the *explicit* of the preceding note.

(2) Clm., ff. 38v-43.

(3) E. g., *ib.*, f. 32v.

(4) *Sphära*, p. 441 ff.; BRUNO A. FUCHS, *Die Ikonographie der sieben Planeten in der Kunst Italiens* (Munich. *Diss.*, 1909), p. 24-29 and plates; SAXL, in *Der Islam*, III, p. 166-168, 175-177, and plate 27; *Catalogus Codicum Astrologicorum Graecorum*, V, part I, p. 86. None of these has compared the figures in the Venice manuscript of the so-called NIMROD (Lat. VIII, 22).

logical writers cited are the usual ones : ALBUMASAR, JAFAR, ZAEL, HERMES, DOROTHEUS, THEBIT BEN KORAH, MESSEHALLA, and the *Centiloquium* (1). In one instance the *Liber novem indicum* is specially commended (2). The author also refers guardedly to more dangerous books : a *Liber perditionis anime et corporis* containing the names, abodes, and workings of demons; and a *Liber auguriorum, ymaginum, et prestigiorum* « which we have seen and possessed in our time, although the Roman church prohibits employing them or believing in them (3) ».

SCOT has plainly gone beyond the books and conducted his own experiments, leading at times to new results (4). That this experimental temper was shared by his imperial patron we know from FREDERICK's treatise on falconry (5), and SCOT gives additional illustrations of this side of the emperor's mind. Not only did FREDERICK, as he himself tells us, have experts brought from Egypt to Apulia to test the incubation of ostrich eggs by the sun's heat (6), but he also experimented with the artificial incubation of hen's eggs (7). SCOT advised the emperor to seek counsel at the time of the new moon (8), and to avoid bloodletting when the moon was in

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(1) On these and similar authorities see the *Speculum astronomie* ascribed to ALBERTUS MAGNUS (*Opera*, 1891, X. p. 629), and by MANDONNET to ROGER BACON (*Revue néo-scolastique*, XVII. p. 313; cf. PALITZSCH, ROGER BACONS *Zweite Schrift über die Kritischen Tage*, Leipzig diss. 1918, p. 12-15), with STEINSCHNEIDER's commentary in *Zeitschrift für Mathematik und Physik*, XVI, p. 357-396 (1871).

(2) Clm., f. 128.

(3) Clm., f, 114, 116v.

(4) « Nos quidem fecimus multa nostris temporibus nobis et amicis de quibus vidimus magnam probationem in rebus divinis prout diverse fuerunt instructione libri ymaginum lune. Verbi gratia quadam vice recipiens semper solis radium per bussulum magnum in culo totum perforatum ad instar sachi discusiti in ymaginem quam faciebamus ad valimentum cuiusdam rei future et optate diu » Clm., f. 114.

(5) See my article, « The *De arte venandi cum avibus* of the Emperor FREDERICK II », in *English Historical Review*, July, 1921.

(6) *Ib.*, p. 342.

(7) « Et istud fecit probare dominus imperator F. multociens et ita est reperta veritas eorundem. » Clm., f. 117.

(8) « Solebamus dicere domino nostro F. imperatori, Domine imperator, si vultis a sapiente clarum consilium, postulate ipsum crescente luna. » Clm., f. 118.

Gemini, lest the puncture be repeated; but the emperor, wishing to test this for himself, called his barber at this season. The barber assured him there was no danger and staked his head upon it, but after a successful puncture he dropped the lancet accidentally on the emperor's foot, causing a swelling which required the care of a *cynigus* for a fortnight (1). Scot also gives his version of an experiment which is recounted to much the same effect by Salimbene (2). Frederick had Scot calculate the height of the starry heavens — whatever that may mean — by the tower of a certain church, and then had the tower cut off somewhat and casually brought Scot back to the site. Scot took his observation and answered that either the heavens were more distant or the tower had sunk a palm's breadth or less into the earth, both of which were impossible, whereupon the emperor embraced him in admiration of his skill (3).

(1) « Eligitur purgatio et diminutio sanguinis et proprie manus luna existente in signo igneo vel aereo, excepto signo Geminorum quod dominatur manibus et brachiis notando quod tunc geminari solet percussio lanceole. Hoc autem voluit videre dominus meus F. imperator et sic quadam vice luna existente in signo Geminorum vocavit suum barberium dicens ei. Est modo tollere sanguinem? Barberius dixit, Sic domine, quia tempus pulcrum est et quietum, vos autem estis bone sanitatis, etc. Cui dixit imperator, Magister, timeo ne bis me percutiatis, quod quando contingit periculosum est, etc. Tunc barberius ait, Domine, volo perdere caput si plusquam semel vos percussero, etc. Tunc dedit sibi verbum et in uno ictu exivit rivulus sanguinis. Letatur barberius dicere imperatori, Domine, timebatis de bina percussione. Habens vero barberius lanceolam in manu apposuit eam sibi in ore, quam cum sic teneret cecidit super pedem imperatoris et imperator fuit in culpa. Illa cum carnem tetigisset exivit sanguis cum dolore et inde secutus est tumor unde locus habuit consilium cynigi 15. diebus. Videns barberius casum et percussam dixit, Domine, grandis sapientia est in vobis et magna provissio futurorum, etc. » Clm., f. 114v.

(2) Ed. Holder-Egger, p. 353.

(3) « De hoc probavit nos imperator in venatione apud turrim cuiusdam ecclesie ville. Facta autem ratione per geometriam et arismetricam ei diximus summam miliariorum et hanc fecit notare in scriptis. Interim fecit latenter truncari turrem per .i. semissum, iterum conduxit me in venatione per illas partes et cum fuimus iuxta turrem finxit se non bene recordari de summa numeri mensurationis cacuminis turris usque ad celum sydereum et sic secundo petiit rationem facti a me. Facta vero ratione sapienter nec invenerim ut prius, dixi, Domine, aut celum superius ascendit quam erat externa die vel turris intravit terram per unum palmum sive semissum, quod est mihi impossibile credere, et cum non perpenderem detruncationem pedis turris factam latenter ipse imperator amplexatus est me et miratus est valde de sententia numeri et omnis qui cum eo erat. » Clm., f. 31.

Apart from these mentions of the emperor, there are few references to Italy. Scot tells us he predicted the rising of Aquila in Italy 20 December (1). He begins the year in the Pisan style (2), and notes that the imperial notaries begin the year at Christmas and the Venetian notaries with the Lord's incarnation (3). In the streets of Messina and Tunis (?) there are fortune-tellers who follow the Oriental precepts of Alchandrinus and seek out newly arrived merchants (4). Among the questions which the astrologer must be prepared to answer are those concerning the acceptance of election as *podestà* or the fate of a city in war (5); indeed the whole account of the wealth and position of the astrologer and his mode of life (6) reflect the influence and position of the profession in the Italy of the thirteenth century.

The *Liber particularis* (7), also written at Frederick's request, is likewise a popular introduction. Much briefer than the *Liber introductorius*, it seeks to supplement this in certain particulars, as the preface explains :

Incipit liber particularis Michaelis Scotti astrologi domini Frederici Rome imperatoris et semper augusti quem secundo loco breviter compillavit ad eius preces, in nomine Jesu Christi qui fecit celum et terram in intellectu, Prohemium.

Cum ars astronomie sit grandis sermonibus phylosophorum et quod

(1) Clm., f. 86v.

(2) *Ib.*, f. 60.

(3) *Ib.*, f. 71.

(4) « Et talis modus qualem Alchadrinus ostendit in generali servatur inter Arabes et aliquos Indorum, ut patet in viis et stratis Messine et Tonisti in quibus sunt mulieres docte que invitant novos mercatores inquirere de statu illorum, de domo sua, de fortuna suae mercationis, etc. » *Ib.*, f. 119.

(5) *Ib.*, f. 133v, 142v.

(6) *Ib.*, f. 118v.

(7) It is found in the Bodleian, MS. Canon. Misc. 555, ff. 1-59, dated 1256 (unless otherwise stated, references below are to this manuscript); the Ambrosian, MS. L. sup. 92, f. 1-89, where the date 1256 also appears; Bibliothèque Nationale, MS. n. a. lat. 1401, f. 129-162v, incomplete at beginning and end, following *Liber introductorius*; Escorial, MS. e. III. 15, incomplete at the end. Vatican, Rossi MSS (*Neues Archiv*, XXX, p. 353f.) ; Breslau, MS. f. 21; (Pertz, *Archiv*, XI, p. 704; Querfeld, p. 14). The extracts in MS. Corpus 221, f. 2-53 (Coxe, *Catalogi*, p. 88) are probably in part from the *Liber particularis*.

de ipsa multi multa scripserunt et diversa veluti cognoverunt semel et pluries experimentis celestium et per celestia de terrestribus, idcirco que compendiose sufficiunt scribere novicio in eadem arte ad preces domini nostri FREDERICI Rome imperatoris et semper augusti iuxta vulgarem in gramatica compillavi ut aliquis novicius hoc opus inveniat quantum per se valeat studere in ipso et de arte astronomie intelligere competenter (1)... ...Sed quia in precedenti libro tractavimus de hiis que utilia sunt et necessaria omni volentium scire prenominatam artem, in hoc secundo libro adhuc recitamus quedam particularia de arte plenius que vero sunt penitus de necessitate cognoscenda pariter et scienda. Et hec que intendimus dicere in illo non tetigimus quod sciamus. Qui vero hos duos libros plene noverit ac sciverit operari nomen novi astrologi optinebit (2).

The treatise contains relatively little astrology in the narrower sense, being devoted to the reckoning of time, where the author cites HELPERIC, BEDE, GERLAND (?), and modern computists (3); sun, moon, and stars; the winds and tides; and various meteorological questions, many of which are also touched in the *Liber introductorius*. The whole is a curious mixture of ISIDORE, Roman tradition, ARISTOTLE'S *Meteora*, ecclesiastical writers, and bits of Arabic learning. The setting is Italian and in large measure Sicilian, mention being found of the *tramontana* and the oppressive south wind, the Germans in the Romagnola and the mark of Ancona (4), the sulphur baths of Montepulciano, Poretta, and Montegrotto (5), and the volcanic phenomena of Sicily.

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(1) Here follow a list of writers on astrology, much as in the *Liber introductorius*, and a list of necessary instruments : « tabule Tolletune vel alie meliores eis ac faciliores si unquam appareant, studiosa compotatio algorismi in suis speciebus, horologium perfectum, astrolabium integrum, quadrans iustum, et spera lignea qua utuntur phylosophi ad oculum cum tractatu regularum Parisiensi, cui spere in nostro magisterio addidimus circulos planetarum sperales quos collocavimus seriatim infra zodiacum cum corporibus planetarum designatis. »

(2) MS. Canon. Misc. 555, f. 1-1v; MS. Ambrosian, L. sup. 92, f. 1-2.

(3) « Computiste ecclesie, ut ALBERICUS, GIRARDUS, et BEDA », MS. Canon. Misc. 555, f. 6v; compotiste moderni, *ib.*, f. 10.

(4) « Idem est de bestiis, verbi gratia gentes Alamanie in asta sunt difficiles gentibus Romaniole ac marchie de Ancona, etc. » MS. Canon., f. 41v.

(5) « Ut patet in Pulicano Viterbii, in comitatu Padue ubi dicitur Mons Gotus, etc. » MS. Canon., f. 43v; see also below.

The most interesting part of the *Liber particularis* is the last quarter, consisting of a series of questions of FREDERICK II on various scientific and quasi-scientific matters, with MICHAEL SCOT's answers. FREDERICK's use of the questionnaire has long been known from the so-called « Sicilian Questions » directed to the various Saracen rulers and preserved in part through the answers of IBN SABIN of Ceuta analyzed by AMARI in 1853 (1). More recently fragments of a set of questions on optics have been recovered by WIEDEMANN (2). The series printed below is, so far as I am aware, unknown and doubtless owes its preservation to its incorporation as an addendum to the *Liber particularis* (3).

Cum diutissime FREDERICUS imperator Rome et semper augustus oppinatus fuisset per institutum ordinem o semetipso de varietatibus tocius terre que sunt et apparent in ea supra eam inter eam et sub ea, quadam vice me MICHAELEM SCOTUM sibi fidelem inter ceteros astrologos domestice advocavit et in occulto fecitque mihi sicut eidem placuit has questiones per ordinem de fundamento terre et de mirrabilibus mundi que infra continentur, sic incipiens verba sua :

Magister mi karissime, frequenter ac multipharie audivimus questiones et solutiones ab uno et a pluribus de corporibus superioribus, scilicet solis et lune ac stellarum fixarum celi, et de elementis, de anima mundi, de gentibus paganis et Christianis, ac de ceteris creaturis que sunt communter super terram et in terra ut de plantis et metallis. Nundum autem audivimus de illis secretis que pertinent ad delectum spiritus cum sapientia, ut de paradiso, purgatorio et inferno ac de fundamento terre et de mirabilibus eius. Quare te deprecamur amore sapientie ac reverentia nostre corone (4) quatenus tu exponas nobis fundamentum terre, videlicet quomodo est constancia eius super habyssum et quomodo stat habyssus sub terra et si est aliud quod sufferat terram quam aer et aqua, vel stet per se an sit super celos qui sunt sub ea; quot sint celi et qui sint sui rectores ac in eis principaliter commorentur; et quantum unum celum per veracem mensuram casset ab alio, et quod est extra celum ultimum cum sint plures et quanto unum celum est maius alio; in quo celo

(1) « Questions philosophiques adressées aux savants musulmans par l'empereur FRÉDÉRIC II », in *Journal Asiatique*, 5e s., t. I., p. 240-274; 7e s., t. XIV, p. 341.

(2) « Fragen aus dem Gebiet der Naturwissenschaften gestellt von FRIEDRICH II ». in *Archiv für Kulturgeschichte*, XI, p. 483-485 (1914).

(3) MS. Canon. Misc. 555. f. 44v; Ambrosian MS. L. sup. 92, f. 69; MS. n. a. lat. 1401. f. 156v, a somewhat different text, briefer at some points but containing the two additional passages printed in the following notes.

(4) Ac imperii maiestatis, the Paris MS. adds.

Deus est substantialiter, scilicet in divina maiestate, et qualiter sedet in trono celi; quomodo est associatus ab angelis et a sanctis, quid angeli et sancti continue faciunt coram Deo. Item dic nobis quot sunt habyssi et qui sunt spiritus commorantes in eis nomine, ubi sit infernus, purgatorius, et paradisus celestialis, scilicet an sub terra vel in terra vel supra terram (1). Item dic nobis quanta est mensura huius corporis terre per grossum et per longum, et quantum est a terra usque in celum altissimum et a terra usque in byssum, et si sit una byssus vel sint plures byssi, et si sunt plures quantum cesset una ab alia; et si hec terra habeat loca vacua vel non ita quod sit corpus solidum ut lapis vivus; et quantum est a facie terre deorsum usque ad celum subterius. Item dic nobis quomodo aque maris sunt sic amare ac fiunt salse in multis locis et quedam sunt dulces extra mare cum omnes exeant de vivo mari. Item dic nobis de aquis dulcibus quomodo ipse omni tempore eructuant extra terram, et quandoque de lapidibus et de arboribus ut vitibus velud in vere apparet per putationem, unde veniunt et surgunt et quomodo est quod earum quedam eructuant dulces et suaves quedam clare et quedam turbide ac quedam spisse ut gummose, quoniam mirramur ex eis valde eo quod scimus iamdiu quod omnes aque exeunt de mari et euntes per diversa loca regionum et venarum adhuc intrent in mare, et ipsum mare est tantum et tale quod est lectus et receptaculum omnium aquarum decurrentium. Unde vellemus scire si sit unus locus per se qui habeat aquam dulcem tantum sicut unus est que habeat aquam salsam, an sit ambarum aquarum unus locus, et si est unus quomodo iste due aque sunt sibi tan contrarie cum ratione diversitatis colorum et saporum atque motuum videatur quod sint duo loca. Unde si sint duo loca aquarum scilicet dulces et salse, querimus certificari quis eorum sit maior et minor, et quomodo est quod hee aque decurrentes per orbem terre videantur eructuare omni tempore ex nimia habundancia sui de loco sui lecti, et licet tam copiose habundent illico tamen non multiplicant quasi ultra communen mensuram ratione tanti additus sed sic stant eructuantes quasi ex una mensura vel ad similitudinem unius mensure. Vellemus etiam scire unde fiunt aque salse et amare que per loca reperiuntur surgitorie et aque fetide, ut in multis locis balnearum et piscinarum, an ex se ipsis fiant vel aliunde. Similiter iste aque que per loca eructuant tepide vel bene calide aut ferventes velut essent supra ignem ardentem in alliquo vase quomodo sunt ita, unde veniunt et unde sint et quomodo est quod aquarum eructuantium quedam semper fiunt clare quedam turbide. Vellemus etiam scire quomodo est ille ventus qui exit de multis partibus orbis et ignis

(1) Here the Paris MS. inserts : « Et que sit differentia animarum que cotidie illuc defferuntur et spirituum qui de celo ceciderunt, et si una anima in alia vita cognoscit aliam et si aliqua potest transire ad hanc vitam causa loquendi et se demonstrandi alicui, et quot sunt pene inferni. »

qui eructuat de terra tam planure quam montis; similiter et fumus apparens modo hic modo illic unde nutritur et quod est illud quod facit ipsum flare, ut patet in partibus Scicilie et Messine sicut in Moncibello, Vulcano, Lippari, et Strongulo. Quomodo etiam est hoc flamma ignis ardentis visibiliter apparet non solummodo in terra sed in quibusdam partibus maris Indie (1).

Then begins Scot's long reply :

« Cui ego Michael Scottus tanquam scottatus a multis et a diversis libere spopondi dicere veritatem cum vehementi admirratione tantarum et talium questionum : O bone imperator, per memetipsum oppinor vehemenler quod si unquam fuisset homo in hoc mundo qui per suam doctrinam evasisset mortem, tu es ille qui inter ceteros debuisses evadere. Sed mors est talis calix et tam communis quod ex eo bibit et bibet omnis sapiens et insipiens, cum in hoc mundo nihil reperiatur fortius morte. Tamen doctrina sapientum vivorum et mortuorum que in hoc seculo dicitur vel scripta reperitur ad instruendum indoctos et ad memorandum peritos donec vita permanet proficit multis et in multis, videlicet quantum ad corpus et quantum ad animam, de qua multum curandum est. Et ideo mihi est valde acceptabile duras questiones audire eo quod tunc proficio in scientia multis modis principaliter dum sunt ipsius scientie qua pocior et glorior inter gentes ac me penes vos video honoratum. Unde sicut constituistis cor vestrum ad has cogitationes questionum quas nunc mihi dilucidastis ordine pretaxato, sic ponite aures vestri capitis ad audiendum et mentem vestram ad intelligendum plenam satisfactionem omnium predictorum que vobis leviter et sine disputatione pandere non pigritabor si Deus voluerit. »

This boastful preface introduces thirty pages of manuscript which it is unnecessary to reproduce in full. Brief statements concerning hell, purgatory, heaven, and the terrestrial paradise are followed by an account of the marvels of nature — strange lakes and rivers of the East, wondrous metals, stones, plants, drugs, and animals, with their respective virtues. The magnet is mentioned incidentally three times (2), each time as something well known. The most interesting

(1) The Paris MS. adds . « Et quomodo est hoc quod anima alicuius hominis viventis dum transierit ad aliam vitam quod nec amor primus nec etiam odium dat sibi causam reddeundi tanquam nihil fuisset, nec de remanenti re videtur amplius curare sive sit salvata sive dampnata. »

(2) « Per calamitam scitur ubi est tramontana cum acu, et cognito domino anni adequatione tabularum de Tolleto scimus quod futurum est in rebus. » MS. Canon. Misc., f. 48v. « Item est lapis qui sua virtute trahit ferrum ad se ut

of these chapters is that on metals, a summary of alchemistic doctrine which can be usefully compared with the alchemical writings attributed to Scot :

Metallum est quedam essentia que dicitur secunde compositionis, cuius species sunt 7, scilicet ferrum, plumbum, stagnum, ramum, cuprum, argentum, et aurum, sciendo quod generantur compositione argenti vivi, sulphuris, et terre. Et secundum unitam materiam eorum quibus componuntur sunt ponderis et coloris. Aurum plus tenet sulphuris quam argenti vivi; argentum tenet plus argenti vivi quam terre et sulphuris; ferrum plus tenet terre quam argenti vivi, etc. Valet quodlibet ad multa ut in compositione sophystica et in aliis virtutibus. Verbi gratia : aurum macinatum valet senibus volentibus vivere sanius et iuniores esse sumptum in cibo, et per eum comparantur multi denarii argenti causa expendendi, fiunt multa monilia, decorantur vasa, et pro eo acquiruntur femine ac multe possessiones. Argentum emit aurum et ex eo multa acquiruntur ut ex auro et fiunt ut denarii, vasa, etc. Stagnum valet ad faciendum vasa et aptandum ferrum laboratum et ramum. Idem dicitur de plumbo ramo etc. Sophysticantur metalla doctrina artis alchimie cum quibusdam additamentis pulverum mediantibus spiritibus quorum species sunt 4, scilicet argentum vivum, sulphur, auripigmentum, et sal ammoniacum. Ex auro cum quibusdam aliis fit plus aurum in apparentia, ex argento et ramo dealbato cum medicina fit plus argentum in apparentia, etc. De argento leviter [fit] azurum. De plumbo leviter fit cerusa. De ramo leviter fit color viridis cum aceto forti et melle. De plumbo et ramo etc. fit aliud metallum. De stagno et ramo fit peltrum cum medicina. Argentum vivum destruit omne metallum ut patet in moneta quam tangit et stagno cuius virgam rumpit tangendo, etc. De plumbo fiunt manubria lime surde quo sonus mortificatur. Argentum vivum interficit edentem et tollit auditum si cadat in aures. Metallorum aqua, ut ferri arsenici vitrioli calcis et viderami, corodit et frangit calibem. Ex vilibus et muracido ferro fit ferrum andanicum, et ecce mirrabile magnum (1).

Coming at last to the emperor's penetrating questions concerning the earth, Scot explains that the earth is round like a ball, surrounded with water as the yolk is surrounded in the egg, the waters being held in their place by a secret virtue; but any further

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calamita et ostendit locum tramontane septentrionalis. Et est alius lapis generis calamite qui depellit ferrum a se et demonstrat partem tramontane austri. » *Ib.*, f. 50. « Calamita reconciliat uxorem ad maritum. » *Ib.*, f. 50v. Cf. *Physiognomia*, part 1, c. i. On the compass in the XIIIth century see the various studies of Schück (*Isis*, IV, 438) and of Günther in *Deutsche Revue*, March, 1914.

(1) MS. Canon., f. 5, MS. Ambrosian, f. 76v.

knowledge of this is beyond human ken and merit. The distance to the extreme of the waters beneath the earth equals the distance to the moon. After air ends fire begins, extending from the moon to the eighth sphere, then a multitude of waters and then the ether as far as the ninth sphere, the spheres being fitted one about another like the layers of an onion. The waters of the sea are bitter because they are older and are not exposed to the sun's heat. Waters were created with inexhaustible virtue of pouring forth so long as the world endures, and they move about in the earth like blood in the veins, the quality of the water depending on the earth through which it passes, and its heat coming from dry, hot rocks, especially sulphur. The hot springs of Montegrotto, Porretta, and Montepulciano and the volcanic outpourings of Etna and the Lipari islands are explained as follows (1):

Nam illius quod me interrogastis de flammis ignis que visibiliter apparent in multis locis huius mundi ut in partibus Scicilie etc., iam supra diximus intellectum huius in capitulo quod incipit, Tellus Scicilie, etc., et in capitulo alio quod incipit. Queri solet de aquis fluminum (2). Sed quia de hoc facta est expressa questio iterum studebimus dictas questiones solvere. Unde dicimus quod in ventre terre sunt saxa sulphuris vivi et petre calidissime nature et in eisdem partibus sunt multe vacuitates quas venas appellamus et fistulas. Causa est fervor caloris quo terra grustificatur cessans a sede illius sulphuris, et ventus qui spirat per orbem reperit fixuras terre in extremis partibus et cavernas qui dum intrat in eas non revertitur retrorsum ymo flat antrorsum de vena in venam et de fistula in fistulam et sic tentans loca cavernosa pervenit ad has vacuitates ubi est tanta copia sulphuris et petrarum calidissimarum, et quia ventus est substantia calida et sicca atque subtilissima et se fricat per tales partes magis subtiliatur, et quia est de materia elementali recipit compositionem qua cum exit de locis apertis usque que (3) continuator illa multitudo sulphuris et petrarum calidissimarum apparet flammabilis vehementer, et a diversis gentibus iudicatur et creditur esse ignis cum habeat omnes condicione signis nostri, scilicet motu sintilis figura dumi fumo et cinere in eisdem partibus. Calore vero tali aer in eisdem partibus inflammatur et fit subtilis calidus et sulphure odoriferus. Unde aque calide et bullientes surgunt

(1) MS. Canon., *f.* 56v-57v; MS. Ambrosian, *f.* 85-86v; not in Nal.

(2) MS. Canon. Misc. 555, *f.* 40, 43, where these topics are more briefly discussed.

(3) *I. e.* usquequaque.

in eisdem partibus et sunt balnee multe, sicut est Pellicanus apud Viterbium, balneum de Porreta, de Monte Gotto in districtu Padue, etc., sciendo quod ubi habundat calor et sulphur sub terra crescit aurum et nascitur, econtra in contraria parte nascitur plumbum ferrum et argentum utrumque. Sunt etiam aque frigide, lacus magni, nives, etc., unde substantia illius flamme ignis parissibilis in certis locis terre et maris non est aliud quam vapor calidus et siccus violenter inflammatus a maiori calore et siccitate, quod totum fit secundum quod prediximus. Et quia ventus non cessat antecedere sive per aerem expeditum ut supra terram sive per cavernas terre prepeditum, aut in exitu loci exit calidus invisibiliter aut inflammabilis visibiliter aut frigidus invisibiliter. Et est sciendum quod si sulphur continuatur producte usque ad exitum venti exit ventus in modum flamme que est magna vel parva secundum quantitatem substantie venti et habundanciam caloris et condictionem aeris quem reperit impeditum ab aliqua impressione vel absolutum, et hoc dico tam de vento invisibili quam visibili et tam de frigido ut in partibus Sclavonie et Alamannie quam in partibus Scicilie, etc. Ut etiam patet per Strongulum montem qui est in medio maris et per Strongulinum, per Vulcanum et Vulcaninum, per Moncibellum et per insulam Lipari in qua sunt omnia genera bonarum arborum et herbarum. Nam Strongulus est mons magnus in mari et de sumitate illius exit continue magna flamma ignis. Similiter exit continue flamma ignis de sumitate montis Strongulini qui est mons minor Strongulo. De Monte Vulcani et Vulcanini, Moncibelli et insule Lippari dicimus quod ex eis quandoque exit flamma ignis ut quociens ventus qui dicitur auster spirat et non alias et quando cessat flamma exit fumus maximus. Et est sciendum quod ista flamma ignis cuiuslibet dictorum locorum sepe importat lapides adhustos et quandoque sticiones lignorum et cinerum que cooperit totam terram inde et aerem sepe obcecat ut est in partibus fluminum de arena. Eiciuntur etiam multi igniculi extra in altum cum flamma ardentiores ut ferrum focine fabri sintillans qui descendendo franguntur in multa frustra et magna et parva, et hec reperiuntur esse pomices quibus utuntur scriptores, et has pomices mare portat ad littora et colliguntur a gentibus et inde murantur domus et parificantur ut apud nos de lateribus, quare in eisdem partibus sunt montes et fragmenta ut de lapidibus apud ceteras regiones. Aqua quidem pellagi est inde frigens et sulphurea unde marinarii transeuntes hinc quandoque implent nodos harundinum et catinos de illa aqua que cum est frigida esse sulphur probatur coagulatione, et est sciendum quod quanto plus aqua accedit prope montes ubi bullit tanto magis sulphur est melior. Verum est quod sulphuris alius albus alius niger alius zallus, etc., sciendo quod unusquisque habet certas virtutes magni valoris, ut in alchimia ad commutandum metalla et ad faciendum focum zambanum, unguenta ad scabiem, etc., suffumigatio cuius dealbat setam zallam et folia rose et lilii et cum ardet reddit

aerem feculentum. Insuper dicimus quod sit illa flamma esset ignis ut noster extingueretur ab aqua que est nostro igni contraria percurrens sub terra in partibus sulphureis in quibus inflammatur, sciendo quod sicut est cursus aquarum super terram et origo fontium lectus fluminum et multitudo lacuum et stagnorum, sic est inter terram. Item dicimus quodsi dicte petre tam calide nature essent super terram sicut sunt in ea absconse et sulphur cum eis, iam mundus esset undique consumatus caliditate flatus ventorum inde transeuntium. Sed cum misericordia Dei sit maxima in dispositione constitutionis mundi, hunc sulphurem et hos lapides locavit inter terram propter melius, nolens quod mundus taliter destruatur, unde voluntate Dei flamme dictorum locorum nec mundum destruunt nec loca sibi propinqua, unde super dictos montes sunt domus que ab hominibus inhabitantur et cultus terre quo fructus habentur multi.

Such evil signs have led many to believe that these volcanoes are the entrance to the hell which is vividly described in the vision of St. Paul in prison; but whether the gate to the lower regions is here or in the northern isle seen by St. Brandan, Scot will not decide. Whatever the way in, hell is in the bowels of the earth, and there is no way out (1).

Scot does not answer all the emperor's questions and his answers are far from satisfactory, yet all is not empty words. He has some acquaintance with the principal sulphur springs and volcanoes of Italy, and, while his knowledge of the Lipari group does not necessarily rest on personal observation, it at least represents inquiry among those who have observed. Although the omission of any special account of Etna is noteworthy, he has in these local matters gone well beyond Aristotle's *Meteorology* and given some real description of volcanic phenomena. Nevertheless, making all allowance for the fact that it is easier to ask questions than to answer them satisfactorily, the emperor's questions show the keener mind

(1) The treatise ends : « Hec autem que breviter et facile diximus nunc ut melius fuit nobis visum, vobis, domine imperator, sufficiant ad presens de recitatione mirrabilium mundi que Deus fecit cum magno delectu ad instar ioculatoris et adhuc facit continue, et de expositione fundamenti terre. Volentes hic finire secundum librum quem incepimus in nomine Dei cui ex parte nostra sit semper grandis laus et gloriosa benedictio et triumphus in omnibus per infinita secula seculorum amen. Explicit secundus liber Michaelis Scotti qui dicitur liber particularis. Nunc incipit liber physionomie »... MS. Canon. Misc. 555, *f.* 59; Ambrosian MS. L. sup. 92, *f.* 88v-89.

and the more penetrating intelligence. They raise real difficulties, and, like those preserved by IBN SABIN, they cut deeply into the current cosmology. That one who can go so far in these directions should at the same time accept implicitly the facile predictions of the court astrologers, is one of the typical contradictions in the intellectual life of the XIIIth century.

Harvard University. CHARLES H. HASKINS.

L'Enseignement de la Mécanique en France au XVII^e siècle

La science avance-t-elle par une série de sauts brusques, correspondant à des découvertes et dus à des hommes déterminés, ou est-elle au contraire le résultat d'une évolution insensible, le fruit d'un effort collectif et en grande partie anonyme? Cette vieille question a été récemment remise à l'ordre du jour, en ce qui concerne la mécanique, par les savants travaux de PIERRE DUHEM. On sait qu'à la suite d'une étude approfondie de l'histoire de la science, DUHEM a formulé des conclusions qui bouleversent l'opinion commune relative aux origines de la mécanique moderne. Celle-ci ne serait pas née brusquement, comme on le croit, au cours du XVII^me siècle. Elle n'aurait pas pour père GALILÉE. Mais elle serait l'aboutissement direct de la pensée du moyen âge qui, à travers de multiples péripéties, aurait lentement mûri au sein des vieilles universités. C'est le fil de cette pensée qu'auraient ensuite repris KEPLER, GALILÉE et DESCARTES. Toutefois leurs contemporains — qui, pour la plupart, ignoraient tout du passé et le méprisaient — ne s'en sont point aperçus. Trompés à leur tour, les historiens modernes crurent de bonne foi qu'une science nouvelle avait été créée par cette poignée d'hommes éminents dont les noms étaient universellement célébrés. Ils méconnurent les philosophes qui avaient précédé KEPLER et GALILÉE; ils ignorèrent les savants plus modestes qui, au XVII^me siècle même, collaborèrent dans l'ombre à l'œuvre collective. De là, sur l'évolution de la mécanique, une vue complètement erronée, que DUHEM cherche à corriger en rétablissant la chaîne continue dont on n'apercevait, avant lui, que quelques anneaux.

Il y aurait beaucoup à dire sur ces conclusions. Je me contenterai aujourd'hui d'insister sur une distinction qui a été déjà bien souvent signalée, mais que DUHEM paraît avoir un peu perdue de vue.

Lorsqu'on étudie l'histoire des problèmes mécaniques et physiques, on doit avoir soin de séparer, d'une part les théories où se reflète l'enseignement donné ou reçu par les savants dont on analyse les œuvres, d'autre part les idées originales qui se sont dégagées de ces œuvres et qui ont exercé une action positive sur le cours de la science. — Les idées directrices qui sont à la base de la mécanique moderne sont relativement simples et peu nombreuses; elles sont précises ou elles ne sont pas, et elles ne comportent pas de degrés; aussi, à qui considérera uniquement les idées et les principes, le développement de la mécanique apparaîtra presque certainement comme discontinu. Au contraire, les conditions dans lesquelles se donne l'enseignement lui confèrent nécessairement — fût-ce d'une manière artificielle — un caractère de continuité. Le professeur d'université, ou l'auteur de manuel, a tendance à toujours répéter les mêmes leçons; lorsque les progrès de la science l'obligent à remanier son cours, il conserve le plus possible des théories anciennes et y insère adroitement les idées ou les faits nouveaux en rendant la soudure aussi peu apparente que possible. Ce travail de mise au point est souvent fait si ingénieusement qu'il devient presque insensible. Aussi l'historien qui jugerait de l'évolution de la science d'après les livres d'enseignement verrait-il celle-ci se dérouler comme une chaîne parfaitement unie, ainsi que le dit Pierre Duhem.

Mais, précisément Duhem ne fonde-t-il pas principalement ses conclusions sur l'étude d'ouvrages qui sont des manuels d'enseignement, des cours de professeurs ? Les traités du moyen âge et du XVI^me^ siècle qu'il a analysés rentrent presque tous dans cette catégorie. Les écrits de jeunesse de Galilée — qui n'ont d'ailleurs pas été publiés de son vivant et auxquels on attache peut-être aujourd'hui trop d'importance — sont le résumé de ses leçons. Les premiers écrits du Père Mersenne sur la mécanique, les traités d'Herigone, du Père Fabri ou du Père Dechales, auxquels Duhem accorde une place importante dans ses *Origines de la statique*, sont des ouvrages purement scolaires. N'est-ce pas parce qu'il s'est longuement attaché à de tels auteurs que Duhem a été conduit à sa doctrine historique?

Nous serons portés à le croire si, en appliquant nous-mêmes la méthode de Duhem, nous cherchons à poursuivre son œuvre. Duhem n'a pas eu le temps d'étudier le XVII^me^ siècle aussi complètement qu'il a étudié le moyen âge. Il a laissé de côté pas mal d'ouvrages qui ne sont guère connus des historiens. Or, si nous recherchons et parcourons

ces ouvrages, nous nous trouvons tout d'abord naturellement entraînés à raisonner comme DUHEM. Non seulement nous rencontrons à chaque pas de nouveaux indices de l'évolution continue dont il nous parle, mais nous voyons les chaînons, les intermédiaires se multiplier de plus en plus. Si nombreux sont les arguments analogues à ceux de DUHEM que nous fournit la période du XVII^me^ siècle que des doutes finissent par naître dans notre esprit. Les raisonnements qui prouvent trop sont suspects à juste titre, car ce sont bien souvent ceux-là qui ne prouvent rien. Et, de fait, une question préalable domine le problème. Parmi tous ces écrits, où les théories scientifiques paraissent s'ébaucher, puis se développer, et se transformer progressivement, quels sont ceux qui ont eu effectivement quelque influence? L'histoire de la pensée scientifique du moyen âge et de la Renaissance nous est trop mal connue pour que nous puissions dire jusqu'à quel point tels ou tels intermédiaires ont été nécessaires, dans quelle mesure telles formes transitoires des théories ont contribué à préparer leur épanouissement final; il est également difficile de savoir quelles connaissances un GALILÉE ou un DESCARTES a directement ou indirectement puisées de l'œuvre du moyen âge (DUHEM n'hésite pas à croire que ces savants ont lu beaucoup plus d'auteurs anciens qu'il n'apparaît d'après leurs citations). Mais, par contre, nous sommes renseignés en détail, par de nombreuses correspondances, sur les relations qu'ont eues entre eux les savants du XVII^me^ siècle. Nous pouvons ainsi contrôler l'impression que nous donne, à première lecture, la série des ouvrages secondaires auxquels je faisais allusion tout à l'heure. Or, si nous procédons à ce contrôle, notre premier sentiment, favorable à la thèse de DUHEM, ne tarde pas à disparaître.

Grâce à l'abondance des documents dont nous disposons pour l'étude du XVII^me^ siècle, nous nous formons une conviction qui équivaut presque à une certitude : les ouvrages d'enseignement, pendant cette période, n'ont joué à peu près aucun rôle dans la formation de la science moderne. Faits de pièces et de morceaux et présentant sous un jour trompeur l'enchaînement historique des théories, ils ne nous éclairent que peu ou point sur la marche véritable de la pensée créatrice. S'ensuit-il, cependant, que l'historien doive négliger les ouvrages de ce genre ? Non, car nombre d'entre eux nous fourniront des indications précieuses sur les circonstances au milieu desquelles la pensée scientifique s'est développée, sur les traditions et les habitudes d'esprit contre lesquelles elle a dû réagir. Ils ne nous

instruisent pas du progrès de la science, mais plutôt ils nous feront connaître les obstacles et les résistances qui ont contrarié ce progrès. C'est là un point de grande importance, et c'est pourquoi l'on doit, à mon avis, étudier attentivement, à la suite de DUHEM, l'histoire de l'enseignement scientifique, tout en la distinguant soigneusement de l'histoire de la science proprement dite.

On trouvera ci-dessous, à l'appui des remarques et des réflexions que je viens d'énoncer par avance, quelques exemples tirés de l'enseignement de la mécanique en France au XVII^me^ siècle et, plus particulièrement, après 1630.

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Dans les ouvrages antérieurs au XVII^me^ siècle le mot même de « mécanique » était le plus souvent employé dans un sens assez restreint (1). Il ne s'appliquait qu'à la théorie des machines simples, étudiée par les méthodes statiques d'ARCHIMÈDE et des Alexandrins ou par les méthodes exposées dans le traité aristotélicien (2) des

(1) Cette acception s'est d'ailleurs conservée pendant tout le XVII^e^ siècle, et nous la retrouvons encore, par exemple, dans le *Dictionnaire mathématique* d'OZANAM (1691). C'est dans cette même acception que DESCARTES prend le mot *mécanique* lorsqu'il compose, à la demande de CONSTANTIN HUYGENS, un petit traité de statique, qu'il appellera « Mes Mechaniques ». MONANTHEUIL définit la mécanique, en termes plus généraux, mais équivalents : « l'art de fabriquer des machines pour tirer, pousser ou porter les corps qui surpassent les forces humaines » ou encore « l'art de forcer les corps autant qu'il est possible à aller contre leur nature ». Un cours que nous citerons plus loin (LE MONNIER, vers 1700) définit semblablement la mécanique « la science qui enseigne par quels moyens les corps difficiles à mouvoir peuvent être mus plus facilement ». La définition d'HERIGONE (*Cours mathématique*, 1634) est plus moderne. Elle se distingue des précédentes en ce qu'elle fait intervenir la notion de *temps* et par conséquent celle de mouvement effectif (et non plus seulement les cas d'équilibre ou de rupture d'équilibre). « La mécanique — dit HERIGONE — est la science qui considère les forces mouvantes et la durée du temps du mouvement ». L'*Abrégé de Méchanique* de SAUVEUR, que nous citerons à la fin de cet article, part d'une définition analogue : « La mécanique est une science qui examine la propriété des mouvements. Dans les mouvements il faut considérer la masse, la vitesse, la direction ou la détermination du corps et la quantité de mouvement ». MERSENNE donne de la mécanique une définition beaucoup plus générale et fantaisiste : la mécanique est un art qui sert, tantôt à imiter la nature comme fait le peintre, tantôt à l'aider comme fait le médecin, tantôt à la contraindre ou à la tromper comme dans les cas des machines, etc.

(2) On sait qu'il n'est pas certain que ce traité soit l'œuvre d'ARISTOTE lui-même.

Questions mécaniques. A côté de cette théorie restreinte, cependant, une autre — plus vaste — était enseignée dans les cours de physique : une théorie générale des mouvements, fondée principalement sur la *Physique* et le *Traité du Ciel* d'ARISTOTE et sur les commentaires relatifs à ces traités. Les cours de physique, qui rattachaient les phénomènes de mouvement à l'ensemble des propriétés du monde, avaient un caractère systématique, logique et dogmatique, tandis que les ouvrages inspirés des *Questions mécaniques* tendaient à revêtir une forme mathématique et s'orientaient vers la pratique.

Ainsi se sont constitués peu à peu plusieurs types distincts d'écrits mécaniques que nous trouvons représentés en France au début du XVII^me^ siècle par des échantillons variés.

On publie encore à cette époque de nombreux commentaires des traités physiques d'ARISTOTE. Citons comme exemples ceux de RUVIO, ceux d'EUSTACHE DE SAINT-PAUL, ceux du Collège de Coïmbre, qui eurent de très nombreuses éditions en plusieurs pays, et qui furent indiqués à DESCARTES par le Père MERSENNE (1). D'autre part, MONANTHEUIL, professeur au Collège de France, publie en 1600 un commentaire (2) des *Questions mécaniques*. Et nous possédons par ailleurs plusieurs traités de statique mathématique du même temps qui s'inspirent principalement des écrits des savants italiens du XVI^me^ siècle, GUIDO UBALDO, BENEDETTI, TARTAGLIA et CARDAN, COMMANDIN et MAUROLICO.

Ces divers ouvrages ressemblent entièrement à ceux qui ont été composés par les générations précédentes. Toutefois on y relève certains caractères qui, s'ils ne sont pas nouveaux, paraissent du moins se préciser et s'accentuer.

En premier lieu, les cours de statique, qui doivent beaucoup, comme je viens de le dire, aux auteurs italiens, se séparent de plus en plus des théories physiques et métaphysiques pour devenir purement mathématiques. Ils savent quelquefois être concis et atteignent un haut degré de précision, se rapprochant par l'esprit et par la méthode de nos livres modernes de statique élémentaire. Comme exemple de traité de ce type, on peut, avec le cours de ROBERVAL (3), citer un traité de mécanique dont deux rédactions

(1) *Œuv. de* DESCARTES, éd. ADAM-TANNERY, t. III, p. 185 et notes *ibid.*, p. 194-197.

(2) ARISTOTELIS *Mechanica*, Paris, 1599.

(3) Voir notamment, sur ce traité, les *Origines de la statique* de DUHEM, t. II, chap. XVII.

d'élèves sont conservées à la Bibliothèque Nationale (1). Le cours d'HERIGONE appartient à la même catégorie, et pareillement celui de MERSENNE (*Mechanicorum* (2) *libri*), dont la matière est riche, mais qui est touffu et mal ordonné. Tous ces traités contiennent — avec la théorie classique des machines simples complétée par diverses additions — une théorie générale des centres de gravité et une théorie de l'équilibre sur le plan incliné.

Dans l'enseignement de la physique, d'autre part (et des lois du mouvement en particulier), nous observons un affaiblissement de plus en plus marqué de la structure logique des théories et de leur caractère systématique. Chaque jour la doctrine perd quelque chose de sa pureté et de sa cohérence. Les vieilles idées d'*éléments*, de *lieu* et de *mouvement naturels*, restent la base des explications données; mais elles ne sont plus définies avec précision, leurs propriétés ne sont pas déduites rigoureusement, et l'on néglige de s'assurer si elles ne donnent pas lieu à des contradictions. Combien le monde savant était devenu indifférent à la pureté logique et philosophique de la doctrine, nous en avons la preuve dans le goût qui se manifeste alors pour les traités de physique simplifiés et abrégés. ABRA DE RACONIS condense la physique en quelques pages dans un minuscule manuel (3) qui a eu de nombreuses éditions et que MERSENNE recommande à DESCARTES (4). Le médecin parisien J.-C. FREY (5) fait imprimer en 1633 un *Compendium* analogue. Les traités sommaires et superficiels, mais faciles à lire, de SAINT JEAN DAMASCÈNE (6) et du philosophe byzantin NICÉPHORE BLEMMIDAS sont traduits en latin et paraissent appréciés.

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(1) Manuscrits, fonds français, 14748 et 14749. La deuxième rédaction est datée de 1708 et contient une allusion à DESCARTES qui ne se trouve pas dans la première. La plus grande partie de ce cours doit remonter au milieu du XVII^e^ siècle; l'auteur ne connaît ni la théorie du baromètre ni, semble-t-il, aucun auteur postérieur à STEVIN.

(2) Cet ouvrage, publié en 1626, dans l'une des éditions de la *Synopsis mathematica* est un livre d'enseignement qui ne contient probablement que peu de parties originales.

(3) Ce manuel parut successivement sous divers titres : *Totius philosophiæ compendia* (1622), *Totius philosophiæ brevis tractatio* et *Universæ Philosophiæ compendium*.

(4) *Œuv. de* DESCARTES, t. III, p. 194.

(5) *Universæ Philosophiæ compendium luculentissimum*, Paris, 1633.

(6) JEAN DAMASCÈNE est traduit par DE BILLY (1603), NICÉPHORE BLEMMIDAS par WEGELIN (1605). Cf. les Préfaces des traducteurs.

En même temps qu'ils perdent leur pureté logique — et à cause de cela même — les traités de physique deviennent volontiers éclectiques. Nous y voyons se côtoyer des explications difficilement conciliables. On se complaît à énumérer, sur chaque sujet, les diverses théories proposées sans se prononcer nettement pour l'une ou pour l'autre.

Nous noterons enfin qu'à l'instar des savants du XVI^me^ siècle, maints auteurs s'évertuent à associer étroitement la théorie et l'application pratique de la science. C'est le cas pour MONANTHEUIL, membre de ce Collège de France qui, depuis ORONCE FINÉ, s'efforce d'introduire la science pratique dans l'enseignement universitaire. Prenant pour texte de ses leçons (1) les *Questions Mécaniques*, MONANTHEUIL y intercale une foule de questions d'actualité, relatives à l'érection de l'obélisque de Rome, à la construction du Pont-Neuf, aux horloges, à l'art typographique, aux mouvements des portefaix parisiens lorsqu'ils soulèvent de grands poids, au mouvement du clou fiché sur une roue (problème de la roulette étudié au XVI^me^ siècle par le Parisien CHARLES BOUELLES). Ce goût de l'application concrète s'affaiblit au cours du XVII^me^ siècle (on le trouve encore chez MERSENNE, un peu chez ROBERVAL, et surtout chez des auteurs moins connus comme HENRION ou JEAN BOULENGER). Mais, vers la fin du XVI^me^ siècle, il contribua fort à faire passer la mécanique au premier rang des études scientifiques. En déclarant que Dieu est géomètre, PLATON — dit MONANTHEUIL (2) — n'a énoncé qu'une partie de la vérité. Dieu est avant tout mécanicien; car, qu'est le monde, sinon une immense machine dont Dieu est le mécanicien. Et c'est pourquoi — ajoute MONANTHEUIL — il n'est pas indigne d'un professeur royal au Collège de France de traiter de la mécanique dans son cours bien que celle-ci ait un caractère d'utilité pratique.

Tels étaient, vers le commencement du XVII^me^ siècle, les caractères des écrits mécaniques les plus répandus. Comment, au cours des années qui suivirent, les ouvrages de ces divers genres se sont-ils transformés? C'est là ce que nous désirons savoir. Or, lorsque nous regardons avec attention tous les traités que nous connaissons, lorsque nous les comparons entre eux, nous sommes conduits à la constatation que j'énonçais plus haut. Il est impossible de découvrir, dans cette suite d'écrits, l'évolution d'une théorie qui se perfectionne, le progrès

(1) Dans l'ouvrage cité plus haut.
(2) *Loc. cit.*, Préface.

d'une pensée qui mûrit. On y voit seulement une série de retouches assez gauches, opérées par insertion de pièces nouvelles plus ou moins bien rattachées, par retranchement d'autres morceaux, par adaptation à des usages nouveaux de certaines notions artificiellement détournées de leur signification primitive.

Voyons, cependant, de plus près sur quelques exemples, comment s'effectue dans la pratique cet ingénieux travail de rapiéçage.

Le remplacement d'une théorie ou d'une hypothèse scientifique par une autre se fait presque toujours de la même manière. Conformément à la tendance éclectique que je signalais tout à l'heure, on commence par indiquer — comme si l'on voulait simplement documenter le lecteur — les diverses explications des mêmes faits proposées par différents auteurs : on continue toutefois à donner la préférence à la théorie consacrée par l'usage. Puis un nouveau pas est franchi : on déclare qu'il est impossible de se prononcer entre les théories en présence et que le problème considéré est litigieux. C'est ainsi que, dans les examens de doctorat, par exemple, un certain nombre de thèses sont présentées comme incertaines (1) : « Incertum est an, ...an, ..., etc. ». Enfin, peu à peu, on laisse tomber les hypothèses surannées pour ne conserver que les nouvelles.

C'est de cette manière — il est facile de s'en convaincre — que l'hypothèse de Copernic (2) s'est peu à peu introduite dans l'enseignement de l'astronomie. Les traités commencent par présenter côte à côte la série des systèmes proposés depuis l'antiquité : système des sphères homocentriques, système de Ptolémée, système dit « des Egyptiens » (ou système d'Héraclide du Pont, dans lequel les

(1) *Cf.* les thèses mathématiques soutenues par Pontchartrain au Collège Louis-le-Grand en 1685, et diverses thèses, soutenues entre 1675 et 1695, figurant dans le recueil coté SX d. 11, à la Bibliothèque de la Sorbonne. On retrouve la même forme d'exposition dans de nombreux ouvrages, — par exemple dans le *Cursus mathematicus* de Millet Dechales (voir t. I, 1674, p. 432) ou dans les *Questions inouïes* de Mersenne, p. 67 (« *On ne sait pas*, etc. »)

(2) *Cf.* notamment, au XVI^e^ siècle, la *Sphère du Monde* de Finé, et, au XVII^e^ siècle, le *Traité de la Sphère du Monde* de J. Boulenger, professeur au Collège de France (quatre éditions au moins, la deuxième en 1628), la *Cosmographie* d'Henrion (1^re^ édit., 1620), la *Nouvelle théorie des planètes* de N. Durret (1635), le *Traité de la sphère de* Ptolémée *et de* Copernic de l'Écossais J. Hume (Paris, 1637), le traité de Forest Duchesne et le cours de Le Monnier cité plus bas, etc., traités dont il faut rapprocher les ouvrages de Mersenne et l'*Institutio astronomica* de Gassendi.

planètes inférieures tournent autour du soleil), système d'ARISTARQUE « et de COPERNIC », système de TYCHO-BRAHÉ. Puis on refuse de choisir entre ces systèmes. Enfin on laisse entendre que l'hypothèse de COPERNIC est la plus vraisemblable et la plus satisfaisante pour l'esprit; et, si néanmoins l'on rejette cette hypothèse, dit un auteur de thèses (1) en 1685, c'est uniquement parce qu'elle est contraire à l'Ecriture. Faisons abstraction de cette dernière restriction, due à la circonstance qu'on est ici en présence d'une condamnation formelle de l'Eglise : il reste un procédé général de transformation, dont nous rencontrons de fréquentes applications lorsque nous étudions l'histoire des théories de la mécanique.

Je ne m'arrêterai pas aux théories relevant de la statique mathématique. Ici, en effet, on marchait sur un terrain sûr. Une vérité mathématique bien établie est définitive. Aussi, en statique, n'a-t-on guère qu'à ajouter et rarement à retrancher. Il y avait cependant dans la statique du début du XVII^me^ siècle certaines taches qu'il fallait faire disparaître, notamment une théorie très défectueuse du centre de gravité (2) (que l'on voulait définir physiquement, comme le point d'un corps qui tend à s'unir au centre du monde, au lieu d'y voir simplement le centre mathématique d'un ensemble de forces parallèles) et certaines applications vicieuses du principe des vitesses virtuelles et du principe des moments. Mais ROBERVAL a su corriger ces défauts sans toucher au reste de l'édifice, et celui-ci s'est trouvé tout prêt à recevoir les additions dues aux recherches personnelles du savant professeur : sa définition précise de la *force*, et surtout la démonstration générale de la règle de la *composition des forces*. D'autres progrès, comme l'introduction du principe de TORRICELLI sur la descente du centre de gravité, furent également réalisés sans effort.

Plus difficile à effectuer était la mise au point des théories relatives au mouvement, le passage de la dynamique du moyen âge à celle de DESCARTES et de HUYGENS (3). La transformation s'accomplit cependant sans heurt, suivant les principes que nous indiquions tout à l'heure.

L'une des principales questions que l'on avait à étudier était celle de la chute accélérée des graves. DUHEM a montré (4) que les physiciens

(1) PONTCHARTRAIN (voir plus haut).

(2) Cf. DUHEM, *Les origines de la statique*, t. II, chap. XV et XVI.

(3) La mécanique de NEWTON et celle de LEIBNIZ n'ont point le temps de pénétrer dans l'enseignement des écoles françaises avant le XVIII^e^ siècle.

(4) *Études sur* LÉONARD DE VINCI, 3^e^ série, 1913 *passim*.

parisiens du XIV^me^ siècle étaient arrivés à formuler certaines hypothèses qui — lorsqu'on les rapproche les unes des autres — donnent immédiatement la loi de GALILÉE. Ces hypothèses, cependant, n'étant étayées, ni par des expériences précises, ni par des raisonnements solides, ne *s'imposaient* pas au monde savant. Chacun restait libre, semble-t-il, de les accepter ou de les rejeter. C'est pourquoi la plupart des cours du XVII^me^ siècle ne regardent pas la question comme tranchée, mais énumèrent simplement les diverses explications de la pesanteur qui ont été proposées. Il se peut — dit une *thèse* (1) de 1685 — que ce soit le mouvement même qui engendre l'accélération, ou bien que la cause mouvante (cause, quelle qu'elle soit, de la pesanteur) imprime au mobile une *qualitas impressa* ou *impetus*, ou bien que le mouvement des graves soit entretenu et accéléré par l'action de l'air. Réduites à des affirmations aussi vagues, les trois hypothèses se laissent concilier, l'une aussi bien que l'autre, avec la loi de GALILÉE (hauteur de chute proportionnelle au carré du temps). Et cette loi peut tout aussi aisément être mise d'accord avec la théorie qui fait dépendre l'accélération de l'attraction : encore que l'on ignore la cause de la « plus grande vitesse » des corps qui tombent, écrit MERSENNE (2) à propos des résultats de GALILÉE, « l'on peut néanmoins expliquer quelques raisons qui satisferont à plusieurs *personnes*, soit que la pesanteur des corps les pousse en bas, que l'air les chasse hors de son lieu, que la terre les attire, ou que ces trois causes et plusieurs autres contribuent à cet effet ». Aussi voyons-nous la loi mathématique de GALILÉE communément admise dans la deuxième moitié du XVII^me^ siècle par ceux-là mêmes qui ne repoussent pas absolument les théories aristotéliciennes (« cette proportion admirable qu'il y a entre la hauteur et le temps de chute ne peut être mise en doute par personne », dit la thèse de 1685 déjà citée). Mais, puisque loi et théorie ne s'impliquent pas nécessairement l'une l'autre, la théorie n'a plus en réalité de rôle à jouer. Elle devient plutôt une gêne et l'on va bientôt juger bon de l'abandonner. Déjà l'auteur de

(1) La thèse de PONTCHARTRAIN, citée plus haut. La troisième explication indiquée ci-dessous est admise concurremment avec la première ou la deuxième par l'auteur de thèses soutenues dans une discussion publique qui eut lieu à Pont-à-Mousson en 1622 (*Selectæ propositiones in tota sparsim mathematicæ pulcherrimæ*, Bibl. Nat. V. 8424) et par GASSENDI dans ses premiers ouvrages (voir les *Epistolæ tres de motu impresso*, 1641).

(2) *Traité des mouvemens*, 1633.

thèses (1) soutenues à Liége en 1603 déclare que l'opinion la plus vraie est l'opinion commune, d'après laquelle « c'est le mouvement précédent qui est la cause de la vitesse plus grande prise par le mouvement suivant ». Or cette opinion ne peut vraiment pas être regardée comme une explication ou une théorie. Ce n'est, en somme, que la constatation même du fait de l'accélération.

La loi du mouvement parabolique des projectiles s'introduit dans l'enseignement (2) tout aussi aisément que celle de la chute verticale. On sait qu'après divers tâtonnements les auteurs du Moyen âge et de la Renaissance, se fondant sur la distinction radicale qui sépare selon eux le mouvement naturel du mouvement violent, s'étaient presque tous arrêtés à une figure de la trajectoire du projectile formée de deux segments rectilignes réunis par un arc de courbe, et fort semblable à une parabole. Les conceptions qui ont guidé ces auteurs n'ont point contribué à préparer la démonstration de GALILÉE sur le mouvement parabolique. Elles nous en éloigneraient plutôt (3). Toutefois — venant après ces essais de solution du problème, assez heureux quant aux apparences données à la trajectoire et confirmés, semblait-il, par la pratique de la balistique — l'apparition de la parabole en la question paraît moins surprenante que si elle était survenue d'emblée.

Le problème des percussions (plus spécialement le problème ayant pour objet la mesure de l'action d'un maillet qui tombe sur un clou) tenait une place importante dans la plupart des cours de mécanique. Mais de ce problème aucune solution précise n'avait été donnée. Dans quelle proportion la force de percussion dépend-elle du poids du maillet et de sa vitesse ? On restait indécis entre diverses époques (4). Aussi la théorie des chocs de billes, qui est le fondement de la mécanique de DESCARTES et qui fut mise au point par HUYGENS, trouva-t-elle

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(1) PETRUS BERTIUS, *De motu gravium et levium*, Liége, 1603.

(2) Cette démonstration repose sur une application particulière de la loi d'inertie, que (comme nous le verrons tout à l'heure) on ne peut mettre d'accord avec la doctrine du mouvement naturel (d'où l'ancienne physique voulait déduire la trajectoire cherchée) qu'à la condition de modifier profondément cette doctrine.

(3) Voir, par exemple, le *Dictionnaire mathématique* d'OZANAM, 1691, p. 334-335. Dans le cours du Père FABRI (voir *Tractatus physicus de motu locali*, rédigé par MOUSNIER, 1644) les voies sont préparées à l'introduction de la trajectoire parabolique.

(4) Voir notamment MERSENNE, *Cogitata physico-mathematica*, 1644, p. 72 et suiv., 85 et suiv., et également MONANTHEUIL, *loc. cit.*, p. 128 et suiv.

facilement moyen de s'insérer dans la physique des écoles (1), bien que son auteur principal eût eu au contraire pour dessein de l'opposer à cette physique.

Si nous en venons maintenant aux questions plus délicates touchant aux premiers principes de la mécanique, nous voyons la transformation des théories s'accomplir d'une manière analogue, quoique avec plus de lenteur et de résistance.

La doctrine *du lieu*, par exemple, appliquée au mouvement des astres et au mouvement centripète des graves, continue longtemps à être enseignée, bien qu'elle se réduise au XVII^me^ siècle à quelques propositions extrêmement vagues. L'*ordre du monde* demande — écrit FOREST-DUCHESNE, professeur de rhétorique, mathématique, philosophie et théologie (2) — qu'autant qu'il est possible les corps graves soient en bas et les corps légers en haut. Ainsi les mouvements naturels des corps sont des mouvements qui ont pour but de rétablir (le plus directement possible, donc en ligne droite) l'ordre de la nature lorsque celui-ci a été troublé. Dans le vide il n'y aurait aucun mouvement naturel des corps graves ou légers, parce qu'il ne pourrait y avoir aucun désordre à réparer; un corps situé dans le vide ne serait donc ni grave ni léger. Le Père FABRI, dans son cours de physique (3), enseigne une doctrine analogue. Le grave se meut naturellement de façon à atteindre le lieu qui lui est assigné (*ut suam finem consequatur*), c'est-à-dire de façon à aller vers le bas. Dans le vide absolu il n'y aurait ni haut ni bas et aucun grave ne se mouvrait naturellement. Mais cette explication de la pesanteur ne joue plus, dans le système de physique enseigné par le Père FABRI, aucun rôle important. Elle n'est là, pour ainsi dire, que pour mémoire. Le Père FABRI déduit en fait les propriétés des corps graves d'un ensemble de définitions qui énoncent les mouvements constatés sans rien postuler sur la cause de ces mouvements. C'est sur de semblables définitions que les thèses de doctorat citées plus haut fondent la théorie des graves, et, dans ces thèses, les lois non établies par l'expérience ne sont rapportées que

(1) Elle est exposée en détail dans un cours de mécanique (*Abrégé de mécanique*) que nous citons plus bas. Cf., également, les *Dialogi physici* du P. FABRI, 1669, et un cours de physique professé à Paris vers 1700 par LE MONNIER, professeur de philosophie.

(2) *Selectæ dissertationes physico-mathematicæ*, 1647, p. 156 et suiv.

(3) *Physica*, Lyon, 1669, t. I, p. 241 et suiv.

comme des propositions douteuses (1) (*incertum est...*). « On ne saurait dire » si les graves se portent vers le centre de l'univers, s'ils tombent vers la terre à quelque distance qu'ils soient placés de celle-ci, si, parmi les corps du ciel, les uns tendent à s'approcher du centre de la terre, les autres à s'en écarter, si la gravité et la légèreté sont deux principes distincts (2), etc. Et l'on se contente donc de définitions comme celles-ci (3) : Parmi les corps, ainsi que nos yeux le constatent, il en est qui se meuvent vers le bas : ils sont dits *graves*; d'autres se meuvent vers le haut, ils sont dits *légers*, d'autres encore se meuvent autour d'un centre, ils sont dits *célestes*. Désormais la porte est ouverte à des explications nouvelles : on est libre de donner comme cause à la pesanteur l'*attraction de la terre* (explication admise par GASSENDI, ROBERVAL, mais qui ne semble pas avoir trouvé grande faveur dans l'enseignement français au XVII^me^ siècle) ou, à l'instar de DESCARTES, certains mouvements tourbillonnaires. De fait, la théorie cartésienne des tourbillons, plus ou moins altérée il est vrai, s'est, comme on sait, rapidement répandue dans les écoles françaises (4).

Nous voyons par les exemples qui précèdent comment les théories et les hypothèses devenues caduques s'éliminent peu à peu, sans bruit, pour faire place à d'autres. Dans certains cas, le processus de transformation est un peu différent, et il est plus curieux encore. Certaines théories vétustes, au lieu de disparaître, s'affirment au contraire autant que jamais, mais se métamorphosent, changent de sens, de

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(1) Thèses de PONTCHARTRAIN, citées plus haut (1685). Cf. le *Cursus mathematicus* de DECHALES (t. I, p. 432 et suiv.).

(2) On savait au moyen âge (comme l'a montré DUHEM) que l'on peut, sans rien changer à ce que l'on enseigne sur les mouvements des corps graves et légers, admettre que la légèreté n'est point une qualité positive, mais seulement une moindre gravité. Cette manière de voir est la seule correcte d'après le cours de LE MONNIER cité plus haut (vers 1700). Dans le traité du Père CASATI (Lyon, 1684) il est affirmé au contraire que la légèreté est une qualité positive. Beaucoup de traités, comme celui de FOREST-DUCHESNE, laissent la question dans le vague.

(3) Thèses de PONTCHARTRAIN. Dans ses *Traités de mécanique* (1679), le Père LAMY procède d'une manière analogue.

(4) Dans l'enseignement de LE MONNIER (vers 1700), elle est devenue partie intégrante du cours de physique. Déjà le Père FABRI enseigne dans sa *Physica* (t. I, 1669, p. 240) qu'aucun corps ne peut descendre sans qu'un autre monte en même temps (mouvement circulaire de DESCARTES).

manière à s'adapter à des conséquences nouvelles. C'est le cas pour la doctrine du *mouvement naturel*, qui, grâce à une ingénieuse interprétation, se mue en un principe nouveau où l'on voit poindre la loi moderne de l'*inertie*.

On sait que la physique ancienne attachait une importance capitale à la distinction du *mouvement naturel* (rectiligne pour les corps terrestres, circulaire pour les astres) et du *mouvement violent*. Mais cette physique enseignait, d'autre part, que les mouvements parfaits sont les mouvements uniformes, et, à ce titre, il semblait que tout mouvement naturel dût être uniforme (ou composé de mouvements uniformes). Comment expliquer alors que la chute naturelle d'un grave soit accélérée? Nous avons rappelé tout à l'heure les causes que l'on imaginait pour rendre compte de cette accélération. ARISTOTE, en particulier, la croyait due à la poussée de l'air, ce qui, au fond, revenait à admettre (sans qu'on le dît expressément) que le mouvement de chute dépend en partie d'une action violente, celle de l'air en contact. Cependant le moment vient où la loi précise de la chute des graves est formulée, et la conviction s'impose que l'accélération est le résultat d'une action de la pesanteur elle-même. GALILÉE constate, d'autre part, que, sur un plan horizontal, si l'on fait abstraction des résistances, tout mouvement uniforme se perpétue de lui-même indéfiniment sans qu'il faille aucune cause (pesanteur ou autre) pour l'entretenir. Bientôt après DESCARTES rend extrêmement vraisemblable cette idée, que les astres eux aussi tendent à conserver vitesse et direction, et que c'est la combinaison d'un mouvement d'inertie avec un mouvement centrifuge ou centripète qui produit leur cause curviligne. Comment faire entrer ces faits dans le cadre de l'ancienne théorie? On y parvient en franchissant une série d'étapes successives, presque insensibles.

Nous nous rappelons que, d'après les physiciens parisiens du XIV^me^ siècle (1), le corps grave qui tombe serait le siège d'un *impetus* qui va continuellement en s'accroissant. Du jour où ils furent familiarisés avec la loi quantitative de l'accélération, les adeptes de cette doctrine admirent tout naturellement que chaque nouvel accroissement d'*impetus* consiste en un degré de vitesse constant qui se perpétue indéfiniment tant qu'aucune cause étrangère ne l'affecte (2),

(1) Cf. DUHEM, notamment dans ses *Études sur* LÉONARD DE VINCI, 3^e^ série, 1913.

(2) Cf. les thèses de PONTCHARTRAIN, la *Physique du Père* FABRI, t. I, p. 246, etc.

en sorte que, par l'addition d'*impetus* égaux dans des temps égaux, le mouvement accéléré se produit suivant la formule de GALILÉE. Ainsi se trouve affirmée la loi de la conservation de la vitesse pour le mouvement rectiligne résultant d'un *impetus* unique. Loi qui est encore fort loin, toutefois, de notre principe d'inertie, car l'*impetus* est considéré par la plupart des auteurs comme une sorte de qualité active, ou de vertu imprimée dans le corps, laquelle est très analogue à la « tendance naturelle » d'ARISTOTE (1). Cette vertu est regardée comme la cause qui entretient la vitesse du grave, et c'est encore par une vertu semblable — ayant la propriété de mouvoir les corps en cercle — que l'école de BURIDAN explique la course des astres. Mais, laissant de côté ces considérations, retenons simplement l'idée générale, très naturelle (et très vague d'ailleurs), de l'addition des *impetus*. De cette idée, un pas facile à franchir nous conduit à la doctrine qui est énoncée par MONANTHEUIL (2) : *Le mouvement vraiment naturel — celui qui se produit sans intervention d'un agent extérieur — est le mouvement rectiligne* (Omnis motus naturalis est per rectam de centro ad locum). Mais, alors, le mouvement des astres, le mouvement accéléré des graves devra-t-il donc être regardé comme un mouvement violent? On s'achemine en effet vers cette idée. « Si l'on demande — dit MONANTHEUIL — pourquoi le ciel se meut circulairement, je répondrai qu'il se meut ainsi, non naturellement, mais par l'effet d'une volonté. Cette volonté est celle d'une intelligence qui gouverne le monde comme notre âme gouverne notre corps. » Et FOREST-DUCHESNE, se servant adroitement de la doctrine (3) des âmes célestes, enseigne (4) que, dans chaque astre, Dieu a logé un ange qui préside à sa course. Ainsi le mouvement d'un astre est, à la lettre, celui d'un corps poussé par un agent étranger. L'*impetus* imprimé à

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(1) GIOVANNI DE GUEVARA dans ses *In* ARISTOTELIS *Mechanicas commentarii*, Rome, 1627, consacre un chapitre à démontrer que la théorie de l'*impetus* n'est pas en désaccord avec la physique d'ARISTOTE (p. 261 et suiv.).

(2) ARISTOTELIS *mechanica*, p. 104. MONANTHEUIL ne se prononce pas, par contre, sur la question de la conservation de la vitesse, et, en un autre passage de son traité (p. 202), il admet, avec beaucoup d'autres auteurs, que l'impetus, du moins l'impetus violent imprimé à un projectile, s'affaiblit peu à peu comme la chaleur que l'on imprime dans un morceau de fer.

(3) Notamment de la doctrine enseignée par NICOLAS DE CUSE.

(4) *Selectæ dissertationes*, 1647, p. 148 et *passim*. Cf. le *Discours sur le mouvement local* du Père PARDIES (2e édit., 1674, p. 43).

un corps terrestre n'est **lui-même** — selon le cours de LE MONNIER (1) — que la *puissance divine* imprimée au mobile, et c'est pourquoi il persévère indéfiniment : l'addition des ***impetus*** dans le grave qui tombe est par conséquent l'effet d'une action extérieure, — de l'action divine.

Ainsi l'on en vient à enseigner positivement que la chute du corps pesant est bien, en réalité, un mouvement violent. Et, dans les thèses de 1685 que nous avons déjà plusieurs fois citées, nous voyons enfin l'action de la pesanteur devenir le type même de l'action violente, en sorte que l'on nous propose de définir une force quelconque comme étant l'agent ou la cause produisant un mouvement uniformément accéléré (c'est-à-dire accéléré dans la proportion qui caractérise la pesanteur). Si l'on admet cette définition de la force et du mouvement violent, l'expression « mouvement naturel » devient alors synonyme exact de « mouvement non accéléré » ou « mouvement d'inertie ».

Tel est, en gros, l'artifice grâce auquel le principe d'inertie peut être introduit dans la mécanique ancienne. Le mot « artifice », certes, n'est pas trop fort ici, car aucune évolution naturelle de la science n'aurait pu aboutir, croyons-nous, à la métamorphose qui vient d'être décrite. La doctrine qui fait du mouvement de la pesanteur un mouvement violent est en réalité inconciliable avec les principes d'ARISTOTE. Elle détruit, en effet, les fondements mêmes de la distinction établie entre les mouvements naturels et les mouvements violents. Prétendre maintenir cette distinction (2) tout en enseignant une pareille doctrine est manifestement un défi au bon sens. Aussi bien le vrai principe d'inertie n'a-t-il été nullement, dans l'histoire, l'aboutissement de la conception aristotélicienne du mouvement naturel, comme certains ouvrages d'enseignement pourraient le faire croire. Il n'est pas entré dans la science par la voie que nous venons de décrire. Mais il a été (incomplètement d'ailleurs) suggéré à GALILÉE (3) par l'expérience; il a été, d'autre part, imposé à GASSENDI par les problèmes de la

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(1) Vers 1700 (voir plus haut). LE MONNIER enseigne que l'énoncé donné par DESCARTES du principe d'inertie n'est pas acceptable parce qu'il porte atteinte à la toute-puissance divine.

(2) OZANAM, dans son *Dictionnaire mathématique* de 1691, donne encore les définitions suivantes incompatibles avec l'idée d'inertie : « Le *mouvement égal* est le mouvement des corps célestes qui se meuvent en rond. Le *mouvement inégal* est le mouvement des corps terrestres, qui n'est pas uniforme. »

(3) Nous savons (cf. les études de DUHEM) que maints philosophes du moyen

théorie atomistique et dicté à DESCARTES par les exigences de son système.

L'analyse que nous venons de faire à propos de la notion de mouvement naturel pourrait être répétée dans bien d'autres cas. Considérons, par exemple, la notion de *moment*. A l'origine, le mot « moment » a un sens très large : c'est la puissance de mouvement que possède un corps eu égard aux conditions dans lesquelles il est placé (1), aux liaisons auxquelles il est soumis [dans le cas particulier d'un corps suspendu au bout d'un bras de levier horizontal, le moment se trouvera être égal au poids du corps multiplié par la longueur du bras]. De cette acception très générale, que l'on particularise et que l'on précise, on passe par degrés insensibles à la définition mathématique que nous donnons aujourd'hui du *moment statique*.

Le mot si fréquemment employé d' « impetus » donne lieu à des observations semblables. En en suivant la fortune, on verrait comment l'*impetus*, qui est originairement une vertu, une qualité imprimée dans un corps, devient, à un certain moment, une *quantité*, la quantité de mouvement de DESCARTES (2).

A mesure, d'ailleurs, que le sens des notions se dégage, les théories qui servaient primitivement à les étayer deviennent superflues, et disparaissent plus ou moins vite. Ainsi, en particulier, une fois venu le

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âge avaient observé avec attention certains effets d'inertie (par exemple la tendance qu'a une meule à continuer à tourner indéfiniment). Mais leurs observations n'étaient pas suffisantes pour leur permettre d'en tirer avec certitude des conclusions semblables à celles de GALILÉE. Ajoutons que le moyen âge (et GALILÉE lui-même à un certain point de vue) croyait que la tendance du mouvement uniforme à se conserver peut exister pour le mouvement circulaire aussi bien que pour le mouvement rectiligne.

(1) C'est ainsi que MERSENNE interprète la notion de « moment » dans son exposé de la statique de GALILÉE (*Les Méchaniques de* GALILÉE, 1634, p. 7).

(2) La mécanique des fluides — que j'ai laissée de côté dans cet article — donnerait lieu à des constatations semblables. Dans les ouvrages du Père NOËL, par exemple, on voit s'opérer le passage entre la théorie scolastique des fluides et la théorie de DESCARTES. — Également instructive est la métamorphose du *centre de violence* d'un corps (point faisant pendant au centre de gravité dans la doctrine qui fait de la gravité naturelle et du mouvement violent deux principes opposés) : au XVII[e] siècle, ce point devient le *centre d'agitation*, et bientôt le *centre d'oscillation du pendule composé* (cf. DUHEM, *Études sur* LÉONARD DE VINCI, 1[re] série, p. 108 et suiv., 147 et suiv.).

jour où l'on dispose des lois mathématiques du mouvement des graves, — du principe de la conservation de la vitesse (introduit comme nous l'avons vu tout à l'heure), — d'une définition précise de la quantité de mouvement et de la théorie élémentaire des chocs, on peut, franchissant un dernier pas, laisser tomber tout le reste : on a alors une théorie dynamique — celle de DESCARTES, revue en ce qui concerne les lois du choc, et complétée par les lois de GALILÉE — qui est parfaitement cohérente et est devenue aussi purement mathématique que le sont les cours de statique. Ce dernier progrès est réalisé (vers la fin du XVII^me^ siècle, sans doute) dans un cours « abrégé » de mécanique dû peut-être à SAUVEUR et qui se trouve parmi les manuscrits de la Bibliothèque Nationale (1).

Avec cet *Abrégé de mécanique* précis et concis — le plus moderne et le plus remarquable des cours que j'ai examinés dans les pages qui précèdent — nous touchons au terme de l'évolution qui a transporté la mécanique du domaine de la physique et de la philosophie dans celui de la géométrie et de l'algèbre. Sans doute bien des maîtres continueront longtemps encore à regarder la théorie des mouvements comme une partie de la philosophie (c'est ainsi qu'elle se présente dans le cours de (2) LE MONNIER cité plus haut. Mais le lien qui rattache cette théorie au reste de la physique est devenu désormais extrêmement lâche et artificiel.

Du point de vue mathématique, par contre, — n'oublions pas de le remarquer — la théorie dynamique exposée dans l'*Abrégé de mécanique* que je viens de citer aura encore beaucoup à progresser pour rattraper la science, qui à la fin du XVII^me^ siècle marche à pas de géant. Dans ce traité, la notion précise de vitesse instantanée (vitesse en un temps t) ne se trouve pas encore (3). La notion de *force* — étrangère, comme on sait, à la dynamique cartésienne qui est

(1) *Abrégé de méchanique*, fonds français 14750. Deux autres cours manuscrits presque identiques se trouvent à la Bibliothèque Nationale, et celui qui paraît le dernier en date est donné comme étant le cours professé par SAUVEUR (1653-1716). Outre les matières dont je viens de faire mention, ces cours contiennent une théorie du mouvement des corps fluides fondée sur les lois du choc.

(2) Vers 1700 (voir plus haut). La théorie cartésienne des chocs occupe la place d'honneur dans les chapitres du cours de LE MONNIER consacrés à la mécanique.

(3) La vitesse d'un corps est simplement définie comme « le plus ou moins de chemin que le corps fait pendant un certain temps ».

fondée uniquement sur la considération des chocs — est absente (1). La *direction* du mobile (« ligne qu'il parcourt ou tend à parcourir (2) ») est encore distinguée de la vitesse (qui, dès lors, n'est qu'un nombre). La notion de *vitesse* ou plutôt de *direction* est présentée en des termes qui rappellent encore trop les anciennes distinctions scolastiques (on nous dit, en effet, que la *direction* est *simple* lorsqu'il n'y a qu'une cause tendant à mouvoir le corps, composée lorsqu'il y a plusieurs causes en présence). Les lois du choc et la distinction des corps élastiques et non-élastiques ne sont pas établies complètement (3). Il reste, on le voit, pas mal à faire pour mettre cet enseignement d'accord avec les travaux de HUYGENS, de NEWTON, de LEIBNIZ. Ce sera là l'œuvre des maîtres du XVIII^me^ siècle.

Collège de France. PIERRE BOUTROUX.

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(1) Le mot « force » apparaît, il est vrai, exceptionnellement en quelques passages, mais seulement comme synonyme de « quantité de mouvement ».

(2) On remarquera la précaution prise ici pour pouvoir appliquer à des mouvements virtuels la définition donnée. La considération de tels mouvements était classique.

(3) On n'y traite que le cas peu intéressant des corps absolument inélastiques (cas étudié en détail par WALLIS).

The development of trigonometric methods down to the close of the XVth century.

(With a general account of the methods of constructing tables of natural sines down to our days.)

This paper serves as an introduction to a study on RICHARD WALLINGFORD'S *Quadripartitum* which will be published (with notes and translation) in an ulterior number of *Isis*. My study of the *Quadripartitum* was undertaken in the summer of 1918 at the suggestion of Professor L. C. KARPINSKI of the University of Michigan, who had himself made a preliminary examination of the manuscript. The introduction is largely based on the late A. VON BRAUNMÜHL'S *Vorlesungen*. It treats the evolution of the methods of plane trigonometry from the earliest times to the close of the fifteenth century. However, since WALLINGFORD makes the methods of calculating tables of sines and chords the central feature of Part I of the *Quadripartitum*, it has seemed advisable not to limit in point of time the treatment of the methods of constructing tables of natural sines.

The whole work, as published in this and following numbers of *Isis*, was submitted as a thesis in partial fulfillment of the requirements for the degree of Doctor in Philosophy in the University of Michigan, 1920. To Professor L. C. KARPINSKI my thanks are due for very helpful directions and criticism throughout the preparation of this dissertation.

In the construction of their pyramids, nearly all of which had their faces inclined approximately 52° to the horizontal, the ancient Egyptians employed the practical equivalent of trigonometric functions. As interpreted by CANTOR (1). DF = *ptr em us* (fig. 1),

(1) CANTOR, *Vorlesungen über Geschichte der Mathematik*, 2nd Edition, vol. 1, p. 59-60. Leipzig, 1898,

DC = *qai en haru*, 2CF = *uxa tebt*, 2CE = *senti*. But *seqt*, « the ratio number », in one plane is $\frac{1/2\ uxa\ tebt}{piremus} = \frac{CF}{DF} = \cos DFC$ and in the other it is $\frac{qai\ en\ haru}{1/2\ senti} = \frac{CD}{CE} = \tan DEC$. The stone-cutters of the pyramids probably used the term *seqt* somewhat as modern carpenters use the word *pitch* in sawing rafters. « The sockets cut into the limestone surface of the desert plateau in which the cornerstones of the Great Pyramid were laid... enabled Petrie to establish the length of the sides as 755 feet. The maximum error he found to be 0.63 of an inch, that is, less than one fourteen-thousandth of the total length of the side. The error of angle at the corners he found to be 12″ of a degree, that is, one twenty-seven-thousandth of the right angle which the architect had laid out at the corner » (1).

With this glimpse at the earliest trace of our science we must turn to astronomy or astrology for further development. In fact it was only with the object of perfecting astronomical calculations that trigonometry was cultivated at all for some 3000 years. The first independent treatise on trigonometry is that by At-Tusi of Bagdad in the thirteenth century, while two centuries more passed before a similar work appeared in Europe. Because of the interest in astronomy, spherical trigonometry was developed prior to the plane, but we shall limit our discussion to the latter.

A. von Braunmühl (2) remarks that while in a papyrus of the early Egyptians was discovered the first trigonometric ratio we possess only fragmentary records of the early astronomical observations and computations. Doubtless the Egyptians and, probably earlier, the Chaldeans cultivated with devotion the pseudo-science astrology, as related by Theon of Smyrna. Among the early Chinese there are also traces of some idea of trigonometric ratio. But the first noteworthy development is to be found among the Greeks, who built their scientific structure upon the foundations erected by the Egyptians and the Babylonians. Indeed the earliest Greek mathematicians and astronomers were travellers who acquired their knowledge at the feet of

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(1) Breasted, « The Origins of Civilization », *Scientific Monthly*, p. 91-92 January, 1920,

(2) A. von Braunmühl, *Vorlesungen über Geschichte der Trigonometrie*, vol. 1, p. 3-6. Leipzig, 1900. Later references to this volume will be devoted simply by Braunmühl.

Egyptian and Babylonian priests. Thus THALES (640-548 B. C.) of Miletus, who spent many years in Egypt and became the first prominent mathematician among the Greeks, learned to determine from its shadow the height of a pyramid and from the similarity of triangles the distance of a ship from the harbor of Miletus.

ANAXIMANDER, contemporary and pupil of THALES, appears to have introduced into Greece the *gnomon* (sun-dial) of the Babylonians : from the lengths of the gnomon and its shadow the determination of the height of the sun leads to the tangent of its altitude.

But it is in the little book of 18 propositions *On the Sizes and Distances of the Sun and Moon* by ARISTARCHUS (about 310-230 B. C.) of Samos that we first find an attempt to calculate trigonometric ratios. HEATH (1) says : « Besides the formal assumptions at the beginning of the treatise, there lie at the root of ARISTARCHUS' reasoning certain propositions assumed without proof, presumably because they were generally known to the mathematicians of the day. The most general of the propositions are equivalent to the statements — If α is what we call the circular measure of an angle, and α is less than $\pi/2$, then (I) the ratio $\sin\alpha/\alpha$ decreases as α increases from 0 to $\pi/2$, but (II) the ratio of $\tan\alpha/\alpha$ increases as α increases from 0 to $\pi/2$". In propositions 7, 11, 12, 13, respectively, ARISTARCHUS reaches conclusions equivalent to the following : $1/18 > \sin 3^\circ > 1/20$, $1/45 > \sin 1^\circ > 1/60$, $1 > \cos 1^\circ > 89/90$, $1 > \cos^2 1^\circ > 44/45$ (2).

The statement of proposition 7, for example, is : « The distance of the sun from the earth is greater than eighteen times, but less than twenty times, the distance of the moon from the earth ». The assumption here is that at dichotomy the angle at the sun is 3°.

HIPPARCHUS, called by the Greeks the Father of Astronomy, was born at Nicea and lived in Rhodes and Alexandria during the period 161 to 126 B. C. That he was also the founder of the trigonometry of chords appears from two sources. THEON (about 365 A. D.) of Alexandria says that HIPPARCHUS wrote a treatise in 12 books on the calculation of chords in a circle, but no trace of this book has been found. Furthermore one work of HIPPARCHUS from a commentary on the astronomical work of EUDOXUS and ARATUS has come down to us, in which he says that he had proved graphically (PETAVIUS' translation

(1) HEATH, *Aristarchus of Samos*, p. 333, Oxford. 1913.

(2) BRAUNMÜHL, incorrectly gives here $1 > \cos 1^\circ > 44/45$, p. 8.

is « per lineas ») in an earlier work all that he used in the commentary (1).

From THEON we also learn that MENELAUS (about 98 A. D.) of Alexandria treated in 6 books the trigonometry of chords, but this book is also lost. However, Arabic and Hebrew translations of the *Spherics* of MENELAUS in 3 books have come down to us (2). Similar works of ANAXIMANDER (about 611 B. C.), AUTOLYCUS (about 330 B. C.), EUCLID (about 320 B. C.), HYPSICLES (about 180 B. C.) of Alexandria, and THEODOSIUS (first century B. C.), of Tripoli contain not a trace of trigonometric computation. But MENELAUS' *Spherics* gives in great completeness the geometric theorems on which Greek trigonometry is built and in the last book treats of the relations between chords and arcs. The first theorem in the second book, generally known as the Theorem of MENELAUS, is the foundation of the laws of the spherical trigonometry that obtained until trigonometry twelve or fourteen centuries later broke the shackles that bound it to astronomy.

The Theorem of MENELAUS may be stated thus : The product of the three ratios of the consecutive segments of the sides of a plane triangle made by any rectilinear transversal equals unity.

Let the transversal intersect the sides of triangle ABC in the points D, E, F (fig. 2). Dropping from A, B, C perpendiculars AM, BN, CP to line FD, we have by similar triangles $\frac{AD}{DB} = \frac{AM}{BN}, \frac{BE}{EC} = \frac{BN}{CP}, \frac{CF}{FA} = \frac{CP}{AM}$.

Whence by multiplication $\frac{AD}{DB}, \frac{BE}{EC}, \frac{CF}{FA} = 1$, or as it is often written, AD, BE, CF = DB, EC, FA.

Now it is to be observed that if we consider the figure ABCDEF a complete quadrilateral, there are involved four distinct triangles and a transversal corresponding to each. But only two of these triangles are considered by MENELAUS, PTOLEMY, and their followers, for as we shall see in the next paragraph, their point of view was wholly different from ours. By them one ratio was always equated to the product of the other two. For example, $\frac{AD}{DB} = \frac{EC}{BE}, \frac{CF}{FA}$, which is always stated

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(1) See BRAUNMÜHL, « Beiträge zur Geschichte der Trigonometrie », *Abh. d. Kais. L.-P. Deutschen Akad. d. Naturforscher*, vol. LXXI. n. 1, p. 4, Halle, 1897.

(2) BJÖRNBO, « Studien über MENELAOS' Sphärik », *Abhandlungen zur Geschichte d. Math. Wis.*, vol. 14, p. 10. Leipzig, 1902.

in words just as we find it in the *Quadripartitum* : « The ratio of AD to DB is composed of the ratio of CE to BE and of the ratio of CF to FA » (1). If in the equation AD. BE. CF = DB. EC. FA we divide by the product of BE. CF and each of the factors on the right successively, we obtain 3 distinct « composed ratios ». By interchanging the denominators on the right of these we obtain 3 other forms. Then because 6 different forms occur with each of the antecedents AD, BE, CF there are in all 18 « modes » to use the classic term employed by WALLINGFORD. THABIT IBN QURRAH (836-901, Bagdad) wrote a work on the « 18 modes » which is extant in the Arabic text and in Hebrew translations, besides Latin versions (2). In his *Liber Abaci* (1202) LEONARD OF PISA translated the Arabic *al-katta* (the cutter) as *figura cata* (3). Later writers evidently adopted simply the term *cata*, for we often find WALLINGFORD speaking of « arranging the *catha* » (or *chata* or *chatha*) for the solution of a particular problem. The ancient theory of the quadrilateral reaches its highest development in AT-TUSI's *Treatise on the Quadrilateral* (4).

The medieval point of view is found in the *Quadripartitum* of which Part III is devoted entirely to the treatment of the quadrilateral. WALLINGFORD says : « I shall draw the two lines AC and AD (fig. 3) from the point A and two other lines CE and DB from the extremities C and D and intersecting in a point G. Then I say that the ratio of AC to AB is composed of the ratio of CE to GE and of the ratio of DG to DB. From B I shall draw a line BF parallel to CG and in the proportion put GE between CE and BF. Then by the argument of Part II 2 (5) the ratio of CE to BF is composed of the ratios CE to GE

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(1) The *regula sex quantitatum*, as this theorem was known when applied to the spherical quadrilateral, is obtained by changing the above lines to arcs and writing « The ratio of chord (2AD) to chord (2DB) is composed of the ratio of chord (2CE) to chord (2BE) and of the ratio of chord (2CF) to chord (2FA) ». It is well to observe that the period covered in this dissertation antedates the symbolic notation and the equation of modern algebra.

(2) BRAUNMÜHL, p. 46.

(3) CANTOR, *Vorlesungen*, vol. 2, p. 15, note 3.

(4) *Traité du Quadrilatère* attribué à NASSIRUDDIN-EL-TOUSSY d'après un manuscrit tiré de la bibliothèque de S. A. CARATHEODORY, Constantinople, 1891. Copy used was loaned by Prof. ALEXANDER ZIWET of the University of Michigan.

(5) Part III is devoted to the application to the *catha* of the theory of the « six quantities » developed in Part II. To us today much of this seems quaint and laborious, for modern methods have greatly simplified the processes.

and GE to BF. But by EUCLID, VI 4 the ratio of GE to BF equals the ratio of DG to DB. Hence the ratio of CE to BF is composed of the ratios CE to GE and DG to DB. But it is known by VI 4, that the ratio of CE to BF equals the ratio of AC to AB. Therefore the ratio of AC to AB is composed of the ratios CE to GE and DG to DB ».

This is the first of 18 cases of *conjunctive catha*, corresponding to external section of the sides of the triangle; these are followed by the 18 cases of *disjunctive catha*, corresponding to internal section of two of the sides. In the second of his two figures PTOLEMY (1) says that one shows « by division » (κατὰ διαίρεσιν) that $\frac{GE}{EA} = \frac{GZ}{DZ}, \frac{DB}{BA}$ (fig. 4). Evidently this is the source of the term *disjunctive* employed by WALLINGFORD. Thence naturally arose the opposite term for the former type.

We may pause here a moment to consider the purpose of the *Quadripartitum*. A perusal of Part I will show that the object in view is the calculation of tables of sines as given by AZ-ZARQALI and, incidentally, tables of chords as given by PTOLEMY. Similarly the ultimate purpose of the remainder of the work is evidently the making of astronomical calculations with the use of the tables of sines. But although the author's primary interest in the work was astronomical, the form of it and various remarks show clearly that he was imbued with the scientific spirit and that he keenly felt the need of a solid mathematical foundation for such work. He complains of the lax methods of his predecessors. For example, in connection with his proof of the Theorem of MENELAUS for the spherical quadrilateral (p. 27, line 11) we read: « Then because the figure of the demonstration varies in three ways and PTOLEMY touched only one of them, in order that we may leave nothing incomplete... let us pursue all three modes » (2). Again (p. 33, line 8) he says: « But first observe that in the *Canones* of ARZACHEL (AZ-ZARQALI) and others the doctrine of this operation (of finding celestial latitude) is not to multiply mean by mean and divide by the first (term of the proportion) but to multiply the first by the third and to divide by the second... » Clearly WALLINGFORD is here endeavoring to make sure of the mathematical basis of his own work.

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(1) *Almagest*, Edition HALMA, vol. 1, p. 51.

(2) Compare BJÖRNBO, « Studien über MENELAOS' Sphärik », *Abhandlungen zur Gesch. d. Math. Wis.*, vol. 14, p. 88-92. Leipzig, 1902.

Claudius Ptolemy who made astronomical observations in Alexandria during the period 125-161 composed in Greek a work of 13 books commonly called the *Almagest* (1) which holds in astronomy the place held in pure mathematics by the *Elements* of Euclid. It is safe to say that all astronomical tables for more than a millennium were based on the *Almagest*. We are chiefly concerned with the first book, in which the mathematical foundation of the work is laid.

Ptolemy divides the circumference into 360 *degrees* and the diameter into 120 *parts* and then subdivides each *part* into *minutes*, *seconds*, *thirds*, etc. (*partes minutæ primæ*, *partes minutæ secundæ*, *partes minutæ tertiæ*, etc.) in the sexagesimal system of the Babylonians with which we are today familiar in the subdivisions of the degree and the hour. He assumes the ratio of the circumference of a circle to its diameter to be $3°\,8'\,30''$, that is $\pi = 3 + 8/60 + 30/60^2 = 377/120 = 3.14166$ (2).

In the *Almagest* are found 4 fundamental principles used by Ptolemy to calculate his table of chords for intervals of 30′ of arc (3).

(I) By the theorems of Euclid are found the sides of the regular triangle, quadrilateral, pentagon, hexagon, and decagon in *parts* of which 60 make the radius. In reverse order the values obtained are : chd $36° = 37^p\,4'55''$, chd $60° = 60^p$, chd $72° = 70^p\,32'3''$, chd $90° = 84^p\,51'10''$, chd $120° = 103^p\,55'23''$. Since the chords of supplementary arcs form with the diameter a right triangle, $\text{chd } 144° = \sqrt{120^2 - (\text{chd } 36°)^2}$, and so for the supplement of any arc whose chord is known.

(II) The so-called Theorem of Ptolemy, « The rectangle (product) of the diagonals of an inscribed quadrilateral equals the sum of the rectangles of the opposite sides », given in the form of a lemma, is used to find the chord of the sum or difference of two arcs. This theorem furnishes the results that we obtain by the addition and subtraction formulas. After proving the general theorem Ptolemy uses the special case when one side is the diameter to find the chord of the difference of two arcs. To show how closely this is related to our trigonometry, we have (fig. 5) : BG, AD = AG, BD — AB, GD, that is chd (AG — AB), $2r$ = chd AG, chd (180° — AB) — chd AB,

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(1) All our references are to Halma's edition, Paris, 1813, which contains the Greek text and a French translation.

(2) *Almagest*, p. 413.

(3) *Almagest*, p. 28-36. See also Braunmühl, p. 19-21.

chd $(180^\circ - AG)$, which is PTOLEMY's formula. If now we put angle $AEG = 2\alpha$, angle $AEB = 2\beta$, and $r = 1$, we have $\sin(\alpha - \beta) = \sin\alpha\cos\beta - \cos\alpha\sin\beta$ (1). The fundamental difference is that our notion of ratio does not enter into the trigonometry of the Greeks or the Arabs. They dealt with the lengths of chords or half-chords (sinus) in a circle of known radius and it was more than eight centuries after PTOLEMY that the thought of making the radius unity occurred to an Arab, ABU'L-WEFA; still later by about six centuries a European, BÜRGI, conceived a like notion (2).

Similarly PTOLEMY finds from the chords of two given arcs the chord of their sum. Thus given (fig. 6) arcs AB, BG with known chords a, b, to find x, the chord of their sum. We have $x = AG = \sqrt{4r^2 - GD^2}$ and $GD = \frac{(a' \cdot b' - a \cdot b)}{2r}$. If we put $AZB = 2\alpha$, $BZG = 2\beta$, $r = 1$, the latter reduces to $\cos(\alpha + \beta) = \cos\alpha\cos\beta - \sin\alpha\sin\beta$.

(III) The chord of the half arc is found from that of the arc as follows (fig. 7): Let $DB = a$ be the given chord, G the mid-point of arc BD, and AD a diameter. Make $AE = AB = a'$ and draw GZ perpendicular to AD. Then $EG = BG = GD$ and $EZ = ZD = \frac{(2r - a')}{2}$ where $a = \sqrt{4r^2 - a^2}$. Whence PTOLEMY gets finally $GD = \sqrt{2r \cdot ZD}$. Making $r = 1$, arc $BD = 2\alpha$, and from the value of ZD obtaining $GD = \sqrt{r(2r - a')}$, we have $\sin\frac{\alpha}{2} = \sqrt{\left(\frac{1 - \cos\alpha}{2}\right)}$. By the use of this theorem are found from the chord of 12° the values chd $3/2^\circ = 1^p 34' 15''$, chd $3/4^\circ = 0^p 47' 8''$.

(IV) By means of an ingenious method of interpolation based on the principle (1) used by ARISTARCHUS, PTOLEMY finds chd $1^\circ = 1^p 2' 50''$. Then by III. chd $1/2^\circ = 0^p 31' 25''$. He now has the complete means of calculating his table of chords for differences of $30'$ of arc, with which he contents himself. We find that his table of chords is accurate to at least five decimal places throughout. For instance set-

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(1) Compare TROPFKE, *Geschichte der Elementer Mathematik*, vol. 2, p. 226. Leipzig, 1903.

(2) For the development of the idea of ratio compare JACKSON, Sixteenth Century Arithmetic in *Columbia Contributions to Education*, Teachers College, Series 8.

ting $r = 1$ and observing that $1^p = 1/60$, we have $\sin 30' = 1/2$, $\text{chd } 1^\circ = 0^p 31' 25'' = 1885/3600^p = 1885/216000 = 0.0087268$ to seven decimal places, which agrees to six places with the correct value 0.0087265.

Improvement of mathematical tables has naturally gone hand in hand with the development of the science, but for our purpose it seems fitting to unify our discussion of trigonometric tables. Hence we shall conclude the treatment of this phase of the subject before proceeding further with the general development of trigonometric methods.

In the *Surya-Siddhanta* the Hindus, assuming $\alpha = 225' = \sin \alpha$ and proceeding for intervals of $225' = 3^\circ 45'$, gave rules equivalent to the formula (1), $\sin(n+1)\alpha = \sin(n\alpha) + \sin\alpha - \frac{\sin\alpha}{\sin\alpha} - \frac{\sin 2\alpha}{\sin\alpha} - \frac{\sin 3\alpha}{\sin\alpha} - \cdots\cdots - \frac{\sin(n\alpha)}{\sin\alpha}$. By subtraction this becomes

$$\sin(n+1)\alpha = \sin(n\alpha) + \left[\sin(n\alpha) - \sin(n-1)\alpha - \frac{\sin(n\alpha)}{\sin\alpha}\right],$$

where $\sin(n\alpha) - \sin(n-1)\alpha$ is the first difference and $\frac{\sin(n\alpha)}{\sin\alpha}$ is the second. Here $r = 3438'$ and the results are in error less than $1''$ in the accompanying table. That the table was not constructed from the rules, but conversely, is shown by the fact that the tabular values exceed by $1'$ those given in some instances by the rules.

Using the Hindu *sinus* or half-chord, the Arabs were able to improve the Ptolemaic tables. Abu'l-Wefa (940-998, Bagdad) calculated a table of sines for intervals of $15'$ in which the error for $\sin 30'$ is only one unit in the ninth decimal place (2). From the sines of 36° and 60°, by the bisection of angles, he readily obtains the values of $\sin 18/32^\circ$, $\sin 15/32^\circ$, and $\sin 12/32^\circ = \sin(36^\circ - 30^\circ)/16$ and then, using the fact that for $90^\circ > \alpha + \beta > \alpha > \beta > 0$, $\sin(\alpha+\beta) - \sin\alpha < \sin\alpha - \sin(\alpha-\beta)$, finds $\sin 16/32^\circ > \sin 15/32^\circ + 1/3\,(\sin 18/32^\circ - \sin 15/32^\circ)$ and $\sin 16/32^\circ < \sin 15/32^\circ + 1/3\,(\sin 15/32^\circ - \sin 12/32^\circ)$. The arithmetic mean gives $\sin 1/2^\circ = \sin 15/32^\circ + 1/6\,(\sin 18/32^\circ - \sin 12/32^\circ)$,

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(1) Burgess, « Translation of the Surya-Siddhanta », *Journal of the American Oriental Society*, vol. 6. 1860, p. 196, ch. II, stanzas 15-16.

(2) Woepcke, « Mathématiques chez les Orientaux », *Journal Asiatique* Series V, vol. 15, 1860, p. 285 and fol.

a value too large by 0.00000 00010 00529 (1). The error arising from the formula of interpolation is about 6 times that of the quantities entering it but the error is only about 1/11 of that of the formula derived from PTOLEMY's method, namely, $\sin 1/2^\circ = 1/3(2 \sin 3/8^\circ + \sin 3/4^\circ)$ (2).

The last and probably the greatest of the Arabic astronomers was ULUG BEG (1393-1449, Samarcand) who found $\sin 1^\circ$ by means of his celebrated third-degree equation

$$x = \frac{\left(\frac{r^2}{4}\sin 3^\circ + x^3\right)}{\frac{3r^2}{4}}$$

in which he replaces x by $\sin 1^\circ$ and solves directly by a very ingenious method of approximation. For $r = 60$ the result in the sexagesimal system is of the form $x = a_0 + a_1/60 + a_2/60^2 + a_3/60^3 + \cdots\cdots$ or as given in the *Prolégomènes*, $\sin 1^\circ = 1^p\,2'49''\,43'''\,11^{iv}$, a result correct to within 1/4 of 1^{iv}, that is within 4 units in the tenth decimal place (3). ULUG BEG's table of sines is constructed for intervals of one minute.

But in Europe little progress was made in advance of the tables of PTOLEMY until REGIOMONTANUS, following PEURBACH's construction of a table of sines with radius 600.000, used the radius 6.000.000 and later made the great step forward of employing a radius of 10.000.000, thus paving the way for decimal values with unit radius. Using $\sin 3/4^\circ + 1/3 \sin 3/4^\circ > \sin 1^\circ > \sin 3/4^\circ + 1/6(\sin 6/4^\circ - \sin 3/4^\circ)$

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(1) For complete geometric proof see BRAUNMÜHL, p. 56-57. But observe typographical errors. In the second of the above inequalities $15/32^\circ$ appears as $18/32^\circ$. Correctly written, $46^v\,40^{vi}\,50^{vii} = 0.00000\,00010\,00529$ and $\sin 1/2^\circ = 0.00872\,65364\,98903$. TROPFKE (vol. 2, p. 298) and CAJORI (*History of Mathematics*, 1919, p. 106) both give this value of $\sin 1/2^\circ$ as correct to the ninth decimal place instead of the eighth.

(2) WOEPCKE, « Discussion de deux méthodes arabes pour déterminer une valeur approchée de $\sin 1^\circ$ », *Journal de Mathématiques*, vol. 19, 1854, p. 159 and fol.

(3) SÉDILLOT, *Prolégomènes des Tables astronomiques d'*OLOUG-BEG, p. 81 and fol. Paris, 1853. Full treatment of the theory involved is given in the above article by WOEPCKE, p. 167 and fol. See also BRAUNMÜHL, p. 73, 74. For $r = 1$ and $x = \sin 1^\circ$ the equation becomes the well known relation $\sin 3^\circ = 3 \sin 1^\circ - 4 \sin^3 1^\circ$. We have here an illustration of the dependence of the trisection problem upon the solution of an equation of the third degree.

and $r = 6.000.000$, by the formula for the half angle he gets $52360 > \sin 1/2^\circ > 52358$. Whence $\sin 1/2^\circ = 52359$. For $r = 1$ this becomes $\sin 1/2^\circ = 0.0087265$, correct to 7 decimal places. The table is constructed for intervals of one minute (1).

The *Opus Palatinum de Triangulis* of Georg Joachim Rhaeticus (1514-1576), finished at Neustadt in 1596 by his pupil, Valentin Otho (1550?-1605), contains the natural values to 10 places (*i. e.* $r = 10^{10}$) of the six trigonometric ratios for every $10''$ sexagesimal. Correcting the work of Rhaeticus and Otho, Bartholomaeus Pitiscus (1561-1613) published at Frankfort in 1613 his *Thesaurus mathematicus sive canon sinuum* containing the natural values of sines and cosines for $r = 10^{15}$ with the same interval of $10''$ (2). But with the invention of logarithms the following year and the subsequent publishing of logarithm tables, the use of tables of natural values of trigonometric functions largely ceased until the recent invention of calculating machines made natural tables again desirable (3).

In the meantime modern analysis has supplied for the construction of such tables manifold methods of computing and checking results. Among the few tables besides those of Rhaeticus that have been computed *de novo* undoubtedly the most notable (4) are the *Nouvelles tables trigonométriques fondamentales* calculated « without personal or mechanical assistance » during the period 1908-1914 by H. Andoyer of the University of Paris. We shall merely outline the method of computing the natural sines and cosines as given by the author (5).

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(1) For further consideration of the work of Peurbach and Regiomontanus see p. 40-43. Braunmühl believes that the above method, evidently based on the Arabic, is due to the influence of Az-Zarqali (Braunmühl, p. 121).

(2) For detailed treatment of these works see Braunmühl, p. 212 and fol. Rhæticus had himself begun the tables with $r = 10^{15}$. He was the first European to discard the arc for the angle by relating functions to the right triangle.

(3) Compare Napier *Memorial Volume*, p. 243 and fol. London, 1915.

(4) Peters published in Berlin in 1911 a table of natural sines and cosines to 21 decimal places for every $10''$ sexagesimal.

(5) The entire work comprises about 1600 quarto pages. The logarithmic tables appeared in one volume in 1911. The natural tables are appearing in three volumes. Vol. 1 (1915) is described below; vol. 2 (1916) contains natural tangents and cotangents; vol. 3 will contain natural secants and cosecants and two auxiliary tables to assist in calculating cosecants and cotangents for angles less than 15°.

Using $\pi = 3.14159\ 26535\ 89793\ 23846\ 26433\ 8 +$ he calculates for convenience the first 50 multiples of π^2 and then obtains from the fundamental formulas of analytic trigonometry established by EULER

$$\begin{aligned}\sin(\pi/2)x = {} & 1.57079\ 63267\ 94896\ 61923\ 1321x \\ & - 0.64596\ 40975\ 06246\ 25365\ 5756x^3 \\ & + \quad 7969\ 26262\ 46167\ 04512\ 0505x^5 \\ & - \quad 468\ 17541\ 35318\ 68810\ 0685x^7 \\ & + \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ & - \qquad\qquad\qquad\qquad\qquad\qquad 18x^{27}\end{aligned}$$

and a similar series for $\cos(\pi/2)x$. Putting $x = y/100$ in these formulas and then giving y the values 1, 2, 3, ... 50, y being thus given in grades (*i. e.* in hundredths of a right angle) denoted by y^{g}, a 20-place table (II) of sines and cosines from 0° to 90° is obtained. This is followed by a table of the variations of these functions from the first to the eighth order inclusive. Next (1) using the $\sin y^{\mathrm{g}}$ for $y = 0, 1, 2, \ldots, 33$ and dividing the interval of this table into 6 equal parts, the values of $\sin(y \pm 1/2)$, $\sin(y \pm 1/3)$, $\sin(y \pm 1/6)$, $\sin(y \pm 5/6)$ are calculated; likewise the cosine. This gives a 17-place table for each 9′ up to 30°. The values from 30° to 45° are found by the formulas $\sin(30° + \alpha) = \cos\alpha - \sin(30° - \alpha)$ and $\cos(30° + \alpha) = \cos(30° - \alpha) - \sin\alpha$ where α varies from 0° to 15°. From these results a table of differences for intervals of 18′ from 0° to 30° is constructed to 20, 22, 24, 26, 28, 30 decimal places for the respective orders 1, 2, 3, 4, 5, 6 (2). Table IV A, containing the sines and cosines and their differences to 15 decimal places for every 10″, is then constructed by means of interpolations from the preceding tables from 0° to 30° (3). To complete the table to 45° use is made of the formulas.

$$\Delta\sin(30° + \alpha) = \Delta\cos\alpha + \Delta\sin(30° - \alpha - h),$$

$\Delta\cos(30° + \alpha) = -\Delta\sin\alpha - \Delta\cos(30° - \alpha - h)$, where h designates an arc of 10″ and $\Delta f(x) = f(x + 10'') - f(x)$ for all values of x. Besides the methods of procedure here outlined ANDOYER presents

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(1) « It is not possible to interpolate directly in these tables (II) to construct by the method of differences the definitive tables which are the chief object of this work : the interval is too great. It is then necessary to construct other intermediary tables (III) which permit us to reach the desired goal. » P. XIII.

(2) For the method of reducing these differences for intervals of 10″ see *Log. Tables*, p. XXIII-XXIV.

(3) For details see *Log. Tables*, p. XXVI-XXVII.

numerous methods that he used to check by other formulas the results already obtained.

Returning now to Hindu trigonometry, we find expressed in words relationships equivalent to $\sin^2\alpha + \cos^2\alpha = 1$ and $\sin^2 2\alpha + \text{versin}^2 2\alpha = (2\sin\alpha)^2$ or $\sin\alpha = \sqrt{1/2(1 - \cos^2\alpha)}$ where $r = 1$ (1). These formulas differ from PTOLEMY's in the use of the *sinus* (half-chord) instead of the whole chord. It was by the use of this more powerful instrument that the Arabs were enabled to build on the Greek foundation of the auxiliary trigonometry of chords the complete and independent trigonometry of the sine.

About the beginning of the ninth century of our era the caliphs of Bagdad gathered together men of learning and set them to translating into Arabic the scientific works of the Hindus and the Greeks. Before the century closed the labors of AL-KHUWARIZMI (about 825), THABIT IBN QURRAH, and others had not only made these treasures accessible to the Arabs but had also given an impetus to independent investigation, as soon evidenced in the work of AL-BATTANI, ABU'L-WEFA, and later AT-TUSI.

Bagdad early IX C.

In his *Opus astronomicum* (2) AL-BATTANI, known in medieval Latin works as ALBATEGNIUS (3), uses *sinus*, *sinus complementi* or *cosinus*, and *sinus versus* but follows closely the older Arabs in blending Greek and Hindu notions. He constructs his table of sines simply by halving the Ptolemaic chords. For determining the altitude of the sun by the shadow, *umbra extensa* (cotangent), of the *gnomon* (sun-dial) of 12 units length according to Hindu custom (cfr. VARÂHA MIHIRA, p. 34) he makes a table (4) for every 1° from 0° to 90° of parts and minutes

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(1) VARÂHA MIHIRA, *Pañchasiddhântikâ*, edition THIBAUT, chap. IV, Verses 3, 4, p. 22.

(2) C. A. NALLINO, AL-BATTANI *sive* ALBATENII *opus astronomicum*, Publicazioni del Reale Osservatorio de Brera in Milano, N. XL, 1913, 1917. The text and annotations by NALLINO, an authority on Arabic science, are in Latin and occupy some 850 quarto pages.

(3) ABŪ ABD ALLAH MUḤAMMAD IBN JĀBIR AL-BATTĀNĪ, called the PTOLEMY of the Arabs, made observations in Ar-Raqqa 879-918 and died in 929.

(4) A similar table but with numerous discrepancies of 1′ is found in the Latin translation by ATHELARD of Bath of AL-MADJRITI's revision of the tables of AL-KHUWARIZMI. (Compare NALLINO, Part II, p. 60, and SUTER, *Die Astronomischen Tafeln des* MUḤAMNED IBN MŪSĀ AL-KWARIZMĪ, p. 174. « Copenhagen, 1914. » That contained in the *Alfonsine Tables* shows inaccuracies mounting to 40′. (RICO Y SINOBAS, vol. IV, p. 8.)

(sexagesimal). The *umbra recta* (or *extensa*) and the *umbra versa* seem to have been viewed as things wholly apart from *sinus* and *cosinus*. Not until the XV^th^ century were they placed by Europeans in the same category by the adoption of a common radius. In addition to the formulas of the *Almagest* AL-BATTANI has expressions equivalent to $c : a = \sin\gamma : \sin\alpha$ and $b : a = \sin\beta : \sin\alpha$ but that he knew the general sine law seems doubtful (1).

In his *Almagest* (2), ABU'L-WEFA (3) explains the character of his work thus : « Although this subject has been treated by HIPPARCHUS, APOLLONIUS, PTOLEMY, and other eminent men of the ancients, we have followed in this book a method indicated by none of them... We have avoided the known methods that are difficult to understand, such as those of the quadrilateral and the six quantities. With the object of arriving at results most easily and directly... we have opened new views and furnished new proofs. We have also added several propositions, very useful in astronomy, which they did not mention ».

We find the equivalents both in *sinus* and in chords of the formulas $2\sin^2\alpha/2 = 1 - \cos\alpha$ and $\sin 2\alpha = 2\sin\alpha\cos\alpha$. He also obtains geometrically $\sin(\alpha \pm \beta) = \sin\alpha\cos\beta \pm \cos\alpha\sin\beta$ after having found by another method without being able to simplify

$$\sin(\alpha \pm \beta) = \sqrt{(\sin^2\alpha - \sin^2\alpha\sin^2\beta)} \pm \sqrt{(\sin^2\beta - \sin^2\alpha\sin^2\beta)}.$$

His proof of the last result is, however, very simple. That for $\alpha + \beta$ follows. Given arcs AB, BC (fig. 8), draw radii OA, OB, OC and to OA, OC the respective perpendiculars BT, BH and join HT. Then HT equals the *sinus* of arc AC. For prolong BT, BH to E, D and join ED. HT then equals half DE because T, H are the mid-points of BE, BD. Therefore arc DBE is twice arc CBA and HT is equal to the *sinus* of arc CA.

Furthermore the *umbra* is handled by him as a genuine trigonometric line and the following relations established : $\tan\alpha : 1 = \sin\alpha : \cos\alpha$; $\cot\alpha : 1 = \cos\alpha : \sin\alpha$; $\tan\alpha : \sec\alpha = \sin\alpha : 1$; $\tan\alpha : 1 = 1 : \cot\alpha$; $\sec\alpha = \sqrt{(1 + \tan^2\alpha)}$; $\csc\alpha = \sqrt{(1 + \cot^2\alpha)}$. Here we have replaced his r by unity. ABU'L-WEFA himself says :

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(1) NALLINO, Part I, p. XLVII.

(2) CARRA DE VAUX, « L'Almageste d'ABU'L-WÉFA ALBUZDJANI », *Journal Asiatique*, series VIII, vol. 10, 1892, p. 408-471.

(3) ABŪ'L-WEFĀ MUḤAMMAD AL-BUZDJANI (940-998, Bagdad).

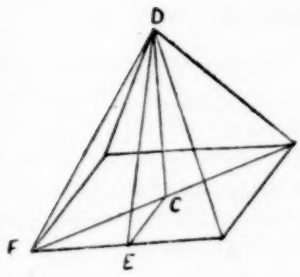


Fig. 1

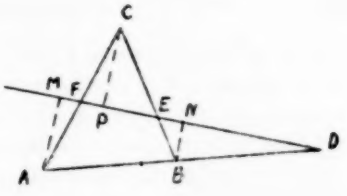


Fig. 2

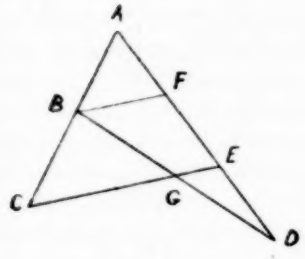


Fig. 3

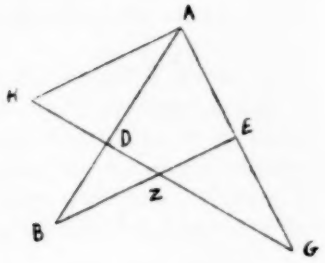


Fig. 4

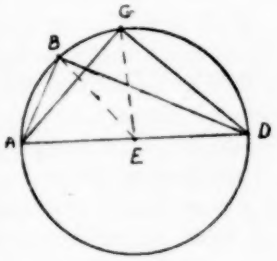
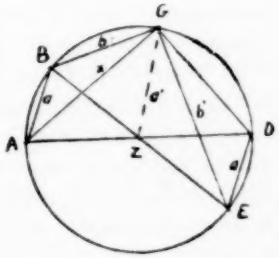


Fig. 5



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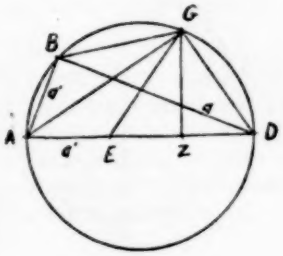

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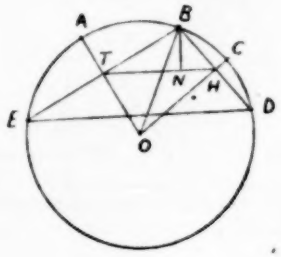

Fig. 8

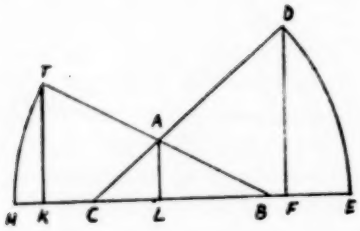

Fig. 9

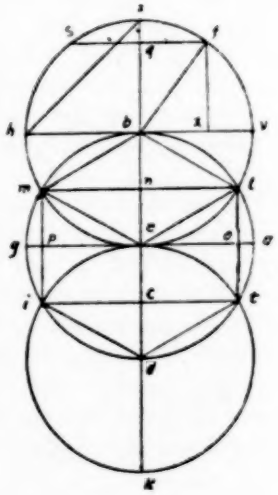

Fig. 10

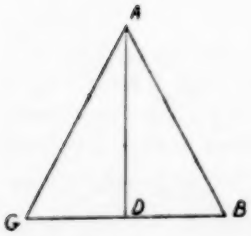

Fig. 11

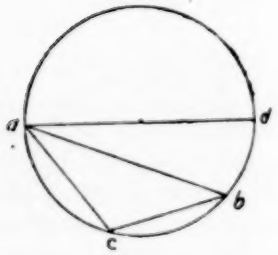

Fig. 12

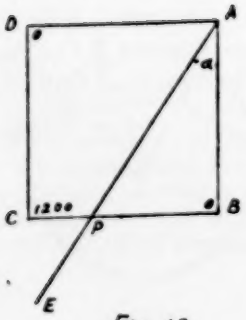

Fig. 13

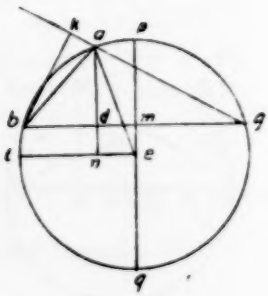

Fig. 14

« It is evident that if one takes the radius as unity the ratio of the sinus of an arc to the sinus of its complement is the tangent (first shadow), and the ratio of the sinus of the complement to the sinus of the arc is the cotangent (second shadow) ». (CARRA DE VAUX, p. 420.) Moreover he constructed a table of tangents and cotangents with the radius, subdivided sexagesimally, equal to unity, an idea ascribed by AT-TUSI to AL-BIRUNI (1). BRAUNMÜHL (p. 58) remarks that the above quotation can not be sufficiently emphasized, for in spite of its clear statement of the idea of setting $r = 1$, the radius was dragged along into the eighteenth century.

Contemporary with ABU'L-WEFA was IBN YUNUS (2), astronomer of Cairo and author of the *Hakimite Tables* which contained, according to HANKEL, the sum total of two centuries of development of Arabic astronomy and was the authoritative source for all later astronomers of the Orient. In his collection of rules, given without proof, is included the equivalent of the formula, $\cos\alpha\cos\beta = 1/2[\cos(\alpha+\beta) + \cos(\alpha-\beta)]$ (3).

In addition to editing and revising many Greek and Arabic works, including a revision of the *Hakimite Tables*, AT-TUSI (4) wrote the important *Treatise on the Quadrilateral* (*Shakl al-Katta*). As previously mentioned, this is the first known work in which trigonometry is treated independently of astronomy. Moreover both plane and spherical trigonometry (5) are developed in great completeness.

The fourth book closes thus : « But the moderns, either from fear of confusion in the investigation of the different ratios and their varieties or to avoid the tedium involved in the use of composed ratios have devised easier methods to take the place of the quadrilateral. Also, once engaged in this study, we thought it useful to speak of these methods in order to give completeness to this branch of science ». Here for the first time in mathematical literature we find the explicit formulation of the sine law for the plane triangle. Two methods of proof for both the acute and the obtuse triangle are given. We shall reproduce one of the former.

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(1) *Traité du Quadrilatère*, p. 165.

(2) ABŪ'L-HASAN ALI .....IBN YŪNUS (JŪNOS), active 1003.

(3) For probable method of proof see BRAUNMÜHL, p. 62-64.

(4) NASIR AD-DĪN AT-TŪSI (1201-1274, Bagdad).

(5) Of the 5 books of the *Treatise* the third is devoted to plane trigonometry and the fifth to spherical.

Let ABC (fig. 9) be the given triangle. Prolong CB to make CE = 60 = R. From the center C with radius CE describe an arc meeting CA produced at D, and from D drop DF perpendicular to CE. Similarly construct TK. Draw AL perpendicular to CB. Then by similar triangles AB : AL = TB(R) : TK and AL : AC = DF : DC(R). Thence AB : AC = DF : TK = sin ACB : sin ABC (1).

Methods of solution of the triangle for all cases, with only one solution for the ambiguous case, are developed but where the sine law is inapplicable the procedure is to reduce to right triangles. An important feature of this work is the reproduction of the methods of proof of numerous predecessors of the author and statements concerning questions of priority. The chief difficulty encountered in studying the historical side of medieval mathematics is the failure of the authors to mention their sources of information.

We must now turn our attention to the West Arabs in Spain, for it was through this channel that mathematics flowed into medieval Europe. Although the East Arabs and the West Arabs possessed the same written language and religion, political animosities broke their free intercourse, so that the works of Abu'l-Wefa and At-Tusi appear to have remained unknown in Europe to the time of Regiomontanus. We shall find that science in Spain did not keep pace with the development in Bagdad.

Az-Zarqali (2) was the most celebrated astronomer of his time. Under his direction a group of Moslem and Jewish scholars constructed the *Toledo Tables* which enjoyed an enormous circulation. The introduction to the tables, entitled *Canones sive regule super tabulas astronomie* (3) and containing besides the canons the explanation of the calculation of the tables, was written by Az-Zarqali himself. Steinschneider records 48 Latin manuscripts of this work in European libraries besides numerous extracts and commentaries in Latin, Hebrew, and Arabic (4). He also observes that although the celebrated

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(1) *Traité du Quadrilatère*, p. 70.

(2) Abū Isḥāq az-Zarqālī (Arzachel of the Latins) made astronomical observations in Toledo 1061-1080.

(3) *Bibliotheca Mathematica*, Third series, vol. 1, p. 337 and fol. Leipzig, 1900. Curtze publishes here the Latin translation by Gerard of Cremona.

(4) *Bullettino di Bibliografia e di Storia delle Scienze Matematiche e Fisiche*, published by Boncompagni, vol. 20, p. 6-32. Rome, 1887. This is one of a series of articles by Steinschneider on the life and work of Az-Zarqali.

Alfonsine Tables were constructed under the inspiration and guidance of King ALFONSO the Wise of Castile in the decade 1262-1272, most of these manuscripts were written after the middle of the XIII^th^ century. The climax of AZ-ZARQALI's astronomical work was his *Safiha* (*saphea*) or universal astrolabe (1).

Having assumed the circumference of a circle to be 360° and the diameter 300′, an innovation found in no previous work, AZ-ZARQALI, following the Hindus, defines the *kardaga* (2) as the arc of 15°, the *sinus rectus* as the half-chord of twice the given arc, the *sinus totus* as the semi-diameter of 150′, and the *sinus versus* as 150′ less the *sinus* of the complement of the given arc (assumed $< 90°$). He then proceeds to give substantially the following description of the accompanying figure (fig. 10). Let the lines *ga* and *bd* intersect orthogonally in the center *e* of the given circle *abgd*, and with the centers *b*, *d* and the given radius let two other circles be described intersecting *abgd* in the points *m*, *l*, *t*, *i*. Then chords *lb*, *bm*, *me*, *el* are all equal, as also their arcs, and *en*, *nb* are each half the radius. Similarly $dc = ce = en$. Hence $lt = mi = cn =$ radius, and the circle *abgd* is divided into 6 equal parts.

Then *mp* (text gives *mg*) = sinus of 30° = 75′ and *mn* = sinus of 60°. Since $zh = \sqrt{45000}$ is the chord of 90°, sinus of 45° $= \sqrt{11250}$. To find the chord of arc $la = 30°$ add the square of *lo*, the sinus of 30°, to the square of *oa*, the difference between the radius and the sinus of 60°, and take the root (3) of the result. Then $la/2$ = sinus of 15°. Again if arc fz = arc $zs = 15°$, fq = sinus of 15° and $qb = fx$ = sinus of 75°. Therefore sinus of 75° $= \sqrt{150^2 - fq^2}$). Now since 2 kardagas = 30° the sinus of 2 kardagas is 75′ and the sinus of 4 kardagas is the root of the difference of the squares of the radius and the sinus of 2 kardagas. Similarly from $la/2$, the sinus of 1 kardaga, find the sinus of 5 kardagas. Then subtract the sinus of 15° from the sinus

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(1) RICO Y SINOBAS, *Libros Alfonsies del Saber de Astronomia*, Madrid, 1864. The third of the five folio volumes is devoted to the construction and use of this instrument.

(2) AL-BIRUNI reports that *kardagia* used to mean an arc of 225′, which is the arc the Hindus considered equal to its sine. The word is perhaps an alteration of the Sanscrit *cramadjya*, which signifies *sinus rectus*. (REINAUD, « Mémoire géog., hist. et scientifique sur l'Inde », *Mémoires, Académie des Inscriptions et Belles-Lettres*, vol. 18, p. 313.)

(3) Here and later the square root is to be understood.

of 30° and the residuum is the sinus of the second kardaga. The difference between the sinus of 30° and the sinus of 45° is the sinus of the third kardaga, and so on (1). We find also the equivalent of

$$\sin 7°30' = \sqrt{\sin 30° (\sin 90° - \sin 75°)} = \sqrt{1/2\,(1 - \cos 15°)}$$ (2).

Then follow the rules for finding the sinus of 82°30', 45°, 22°30', 67°30', 11°15', 78°45', 37°30', 52°30'.

Using the Hindu *gnomon* of 12 units length but retaining his own radius of 150', he finds the shadow of the sun from its altitude, and conversely, by formulas equivalent to

$$\cot \alpha = \frac{\cos \alpha}{\sin \alpha}, \quad \cos \alpha = \frac{\cot \alpha}{\sqrt{\cot^2 \alpha + 1}}, \quad \sin \alpha = \frac{1}{\sqrt{\cot^2 \alpha + 1}}.$$

As values of π he gives 22/7, $\sqrt{10}$, 62832/2000.

The work of JABIR (3), 9 books on astronomy, in the translation of GERARD OF CREMONA was published by PETER APIAN in 1534 (4). Proposition XXIV of the first book follows.

« And since this has already been explained let us begin to show how the unknown sides and angles of a triangle are found from the known, *in order that we may avoid repetitions*. Therefore I say that when in a rectilinear triangle *abg* (fig. 11) two sides *ab*, *bg* and the included angle *b* are known, the side *ag* and the two remaining angles are also known. And this is the proof. I shall draw from point *a* to line *bg* the perpendicular *ad*. Then because angle *abg* and line *bg* are known it is known whether *ad* will fall within or without *bg*. And since *d* is a right angle line *ab* is the diameter of a circle which contains triangle *abd*. Also since angle *b* is known the arc of this circle above *ad* will be known. Therefore the chord *ad* will be known from the measure (quantitatem) by which the diameter of the circle is known. Hence the line *bd* is known. Then since line *bd* is known

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(1) This is doubtless closely connected with the Hindu rules for calculating their table of sines and the method of differences employed in these rules. See page 303 above.

(2) « Si autem volueris invenire sinum secundum minores circuli porcionis, sinum huius kardage sexte in sinum 30 graduum multiplica, et collecte inde summe quere radicem, que erit sinus 7 graduum et dimidii. » This, the complete explanation of the above equation, illustrates the absence of proofs in *Canones*.

(3) ABŪ MUḤAMMAD JĀBIR IBN AFLAḤ (GEBER of the Latins) was active in Seville between 1140 and 1150.

(4) *Instrumentum primi mobilis a* PETRO APIANO... *Accedunt iis Gebri filii Afla Hispalensis... libri IX de astronomia... Norimb.* 1534, in folio.

in relation to lines *ab* and *bd* line *dg* is also known. And since it has already been shown that line *ad* is known therefore must line *ag* be known. Therefore by the measure by which side *ag* is 120 is the perpendicular *ad* known. Therefore the arc *ad* in the circle containing triangle *adg* is known. Hence angle *agd* is known, and since angle *abg* was already known angle *bag* is known. Therefore all the sides and angles of the triangle are known and the proof is complete. »

We observe that JABIR divides the triangle into two right triangles about which he circumscribes circles and finds the unknown parts by the method of chords. The first sentence quoted above shows that he felt the need of an independent trigonometry but the chief value of the work concerns spherical trigonometry and astronomy and therefore need not detain us further.

Turning now to Christian Europe, we find hardly a trace of our science until the twelfth century, about the time Archbishop RAIMOND (between 1130 and 1150) instituted in Toledo a school of translators of Arabic works. From the time of Gerbert (940-1003, in 999 became Pope SYLVESTER II) who probably possessed Arabic works in Latin translation (1) interest in the philosophy of ARISTOTLE and consequently in astronomy and mathematics grew until, with the waning of Moslem power in Spain, the Christians, assisted by Jewish scholars, in the XIIth century attained an activity in translating Arabic works that rivalled that of the Arabs themselves in their acquisition of the treasures of Greek and Hindu learning. The most prolific of these translators was GERARD OF CREMONA (1114-1187). Among the 76 works that he turned into Latin were PTOLEMY'S *Almagest*, the *Canones* of AZ-ZARQALI, the *Spherics* of MENELAUS, and the works of JABIR and THABIT IBN QURRAH. JOHN OF SEVILLE (active 1135-1153), known also as JOHN OF LUNA and as JOHANNES HISPALENSIS, produced a Latin version of AL-FERGANI'S (ALFRAGANUS in Latin) astronomy, PLATO of Tivoli (about 1136) translated AL-BATTANI'S *De motu stellarum* and the Spherics of THEODOSIUS, and ATHELARD OF BATH (between 1120 and 1130), one of the earliest in this field of activity, made accessible to the Latins the astronomical tables of AL-KHUWARIZMI (2).

Toledo
1130-1150

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(1) DUHEM, *Le système du monde*, vol. 3, p. 163-165. Paris, 1915.

(2) See also HASKINS, « The Reception of Arabic Science in England », *The English Historical Review*, Jan. 1915, p. 56-69. Here are discussed the labors of WALCHER, PETRUS ANFUSI, ROBERT OF CHESTER, ROGER OF HEREFORD, DANIEL OF MORLEY, etc.

Italy
1202

With the opening of the thirteenth century we observe the transition from mere translation to constructive mathematical production. In the year 1202 LEONARD OF PISA, called also FIBONACCI, published his *Liber Abaci*, of great importance in the history of arithmetic and algebra, and in 1220 his *Practica Geometriæ* (1), in which for the first time surveying by trigonometric methods is reduced to a mathematical basis. While earlier works on surveying had been for the most part a collection of rules, LEONARD OF PISA gave derivations and proofs. His knowledge of trigonometry is derived from PTOLEMY but he defines the *sinus rectus* and *sagitta* (sinus versus) like the Arabs. His table of chords and arcs is constructed with a diameter of 42 *perticæ* and circumference 132 *perticæ*, where 1 pertica (measuring rod) = 6 *pedum* = 108 *unciarum* = 2160 *punctorum* (2). With his quadrant (3), constructed after the manner of the Arabs, can be read from the position of the plumb-line the *umbra recta* and the *umbra versa* though the term *umbra* does not appear (4). However, in the work of ROBERT THE ENGLISHMAN (about 1231, Montpellier) we find expressed between the two *umbræ* the relation which is equivalent to $\tan \alpha \cot \alpha = 1$.

Apparently the *Toledo Tables* were little known to the Latins until they appeared in the writings of WILLIAM THE ENGLISHMAN (about 1231, Marseilles) (5). We have already referred (p. 313) to the important astronomical compilation of which the *Alfonsine Tables* formed a part. We may add here that LUCAS GAURICUS (1476-1558), an Italian astrologer and a prolific writer, attributes to CAMPANUS OF NOVARA (active about 1260-1280) a true table of tangents for each degree from 0° to 45°. This antedates by about two centuries the *tabula fœconda* (see p. 322) of REGIOMONTANUS which, apparently with good reason notwithstanding GAURICUS' statement, has been supposed the earliest constructed in Europe.

An anonymous manuscript bearing close resemblance to the *Quadripartitum* was published by CURTZE, who shows that the supposed

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(1) BONCOMPAGNI, *Scritti di* LEONARDO PISANO *del Secolo Decimoterzo*. Rome, 1862. *Practica Geometriæ* is the second volume of the *Scritti*.

(2) *Practica Geometriæ*, p. 95.

(3) Same, p. 206.

(4) Compare BRAUNMÜHL, p. 96-98.

(5) DUHEM, vol. 3, p. 315. In the Latin texts WILLIAM is often designated simply as « MARSILIENSIS ».

author was only a commentator and that instead of belonging to the fifteenth century as was formerly supposed the manuscript belongs to the thirteenth century (1). It occupies folios 83^a — 103^b of an excellent manuscript of 127 leaves containing 11 other works. We find in it the terms *gardaga* (kardaga, p 313 above), *cada* (catha, p 299) (2), *sinus rectus*, *sinus versus*. The diameter is assumed to be 300 minutes (300 minutorum) for sines and 120 degrees (120 graduum) for chords. There is one numerical and one linear demonstration of a ratio composed of ratios. The figure illustrating the application to the *catha* and labelled *cada coniuncta* corresponds to WALLINGFORD's *catha disiuncta* and there is no figure given in the second case. The application of PTOLEMY's Theorem to the case when one side of the quadrilateral is a diameter of the circle and to finding the chord of the sum and of the difference of the arcs of two given chords concludes the part preceding the astronomical section, that is to folio 87^a. The latter part of this treatise contains a section on the *umbra*, a subject not found in the *Quadripartitum*. Now WALLINGFORD devotes two-thirds of the 46 pages of his work to laying the mathematical foundation whereas the other uses only 8 and in these 8 pages no author or theorem is cited. Our conclusion is that the two works can be only indirectly connected through common sources; a single source seems quite improbable.

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(1) *Bibliotheca Mathematica*, Third Series, vol. I, Leipzig, 1900. Under the title : « Urkunde zur Geschichte der Trigonometrie im christlicher Mittel alter », CURTZE gives the Latin texts of parts of 8 important manuscripts as follows, the fourth being that under consideration above :

1. Aus dem *liber embadorum* des SAVASORDA in der Uebersetzung des PLATO VON TIVOLI, p. 321-337.
2. Aus dem *Scripta* MARSILIENSIS *super Canones* ARZACHELIS, p. 347-353. (Compare page 312 above.)
3. Aus den *Canones sive regule super tabulas Toletanas* des AL-ZARKÂLÎ, p. 337-347.
4. *Anonyme Abhandlung über Trigonometrie aus dem Ende des* XIII *Jahrhunderts*, p. 353-372.
5. Aus LEO DE BALNEOLIS ISRAHELITA *de sinibus, chordis et arcubus, item instrumento revelatore secretorum* p. 372-380.
6. Anonyme Abhandlung *De tribus notis*, p. 380-390.
7. Die *Canones Tabularum primi mobilis* des JOHANNES DE LINERIIS, p. 390-413.
8. *Die Sinusrechnung* des JOHANNES DE MURIS, p. 413-416.

(2) Both CURTZE and BRAUNMÜHL say that the variation of the consonants indicates Saxon authorship.

To the year 1321 belongs Leo de Balneolis Israhelita *de sinibus, chordis et arcubus...*, (1) of Levi ben Gerson (died 1344, Avignon), known also as Leo de Balneolis. It contains 9 chapters, of which the second, composed of 5 parts (*dictiones*), is of special interest for the history of trigonometry. The *dictio prima* gives definitions and explanations of degrees, minutes, etc., signs of the zodiac, division of the diameter into 120 degrees (« not equal to the degrees of the circumference »), arc, chord, *sinus*, and *sagitta*. The *dictio secunda* contains the derivation of the relations which we write thus :

$$\text{versin}\,\alpha + \cos\alpha = 1, \quad \text{versin}\,(90^\circ + \alpha) = 1 + \sin\alpha,$$
$$\text{chd}^2\,(\alpha \pm \beta) = (\sin\alpha \pm \sin\beta)^2 + (\text{versin}\,\alpha - \text{versin}\,\beta)^2;$$

the relation $\text{chd}^2\,\alpha$ = sagitta·diameter; and the fact that the chord of the half arc is known from the chord of the arc. From these relations Levi ben Gerson constructs a table of sines for intervals of 15′. From the sines of 90°, 60°, 36° are obtained besides the sines of the halves of these angles the sines of 24°, 6°, 8°15′ (6° + 2°15′), and finally of 15′ + 1/128° (33/128°) and 15′ − 1/64° (15/64°). Thence is found the *sinus* of 15′ = 0°15′42″ 28ᵐ 12ᵛ 27ᵛ, a value correct to 7 decimal places. Some further calculation concludes *dictio tertia*. In *dictio quarta* is given the *Tabula sinus* and the explanation of its use for finding the *sinus* and the *sagitta* from the arc, and conversely. *Dictio quinta* (2), containing the theory of the solution of triangles, is an important independent contribution by Levi ben Gerson. It contains the following propositions :

(I) Given two lines in a right triangle, the remaining parts are known.

(II) Given the three sides of any triangle, all the angles are known.

(III) Given two sides and the angle opposite one of them, the remaining side and angles are known. (Only one solution.)

Corollary A. « In every triangle one side has to another the same ratio that one sinus of the angles subtended by the lines has to the other ».

Corollary B. If the angles and one side of a triangle are known, so are the remaining sides.

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(1) See note, p. 317. This work was translated from Hebrew into Latin in 1342, a fact to which we shall later have occasion to refer.

(2) This part is not given in the above citation but was published by Curtze in *Bibliotheca Mathematica*, 1898, 2nd series, vol. 12, p. 103-106.

(IV) Given two sides and the included angle of a triangle, the remaining parts are known.

Here appears for the first time in the mathematical literature of Europe the clear and definite statement of the sine law. Also the four theorems here presented show great contrast with a similar work on the solution of triangles, *De tribus notis* (1), written about the same year and containing separate treatment of 25 different cases. The method of *De tribus notis* is that of JABIR, that is to divide each triangle into two right triangles and solve by means of the chords and arcs of the circumscribed circles. LEVI BEN GERSON uses the Pythagorean Theorem and the *sinus* in the first case; in the second he determines the height by the Euclidean method and then applies the *sinus*. We give below a rather free translation of his proof of the third case. He uses the same figure in the fourth (2).

In triangle *abc* (fig. 12) let the lines *ab*, *bc* and the angle *bac* be known. I say that the line *ac* and the remaining angles are known. To prove this let a circle be passed through the vertices of *abc* and let *ad* be the diameter of this circle. Because angle *bac* is known and inscribed in the circle of which 360 degrees subtends two right angles therefore *bc* will be known and from the tables of arcs and sines we shall know the chord *bc* in terms of the 120 degrees of *ad*. So we know the ratio of *cb* to *ad*. Then from the known ratio of *bc* to *ab* is known the ratio of *ab* to *ad*. Then we know the value of *ab* in degrees (diametral) and from the tables we shall thus know arc *abc*. Therefore we know arc *ac*, the difference of the known arcs. Hence from the tables we know angle *abc*. Finally from the two known angles we know the third angle. Therefore etc.

The *Canones tabularum primi mobilis* (3) of JOHANNES DE LINERIIS, without mentioning any source, employs verbatim the method of calculating the *sinus* found in the *Canones* of AZ-ZARQALI. Among the tables are *tabule sinuum et cordarum*, *tabula umbre*, and *tabula proportionis*. JOHN OF MEURS, in the last of the CURTZE group of manuscripts, shows some independence by constructing a figure of his own to replace that handed down from AZ-ZARQALI. The *Practica geometriæ* shows that its author DOMINICUS DE CLAVASIO (active 1349-1357, Paris) was acquainted with *sinus*, *sinus versus*, *complementum*

(1) See note page 317.

(2) Compare BRAUNMÜHL, p. 103-106.

(3) Written in Paris, 1322. See note, p. 317.

sinus versus, *umbra recta*, *umbra versa* and well versed in EUCLID, PTOLEMY and WITELO. Moreover he gave strict proofs for the rules he set up for surveying (1).

JOHANN SCHINDEL (1380?-1442), known also as JOHANNES DE GEMUNDEN, wrote JOHANNES DE GEMUNDEN *de sinibus, chordis et arcubus* in which appear the terms *sinus rectus*, *sinus versus* and *sagitta*, *sinus totus* or *perfectus*, *cardaga*. As in our tables he uses proportional parts and gives the differences. With him originates the radius of 600 000 though the idea of combining decimal and sexagesimal measurement may have been due to JOHANNES DE LINERIIS. It remained for GEORG PEURBACH (1423-1461, Vienna) to construct a complete table of sines for intervals of 10′ with the above radius (2). It is interesting to note that PEURBACH was the first to employ the « geometric square » for astronomical as well as for terrestrial measurements (3). Instead of he usual 12 units for the length of BC (fig. 13) he uses 1200. He finds

$$\sin \alpha = \left[\frac{a}{\sqrt{(a^2 + 1200^2)}}\right] \cdot 600000$$

where $a =$ BP. So we really have a table of arctangents, since $\alpha = \arctan a/1200$.

JOHANNES MÜLLER (1436-1476), generally known as REGIOMONTANUS from the Latin name of his birth place, Königsberg, became at the age of 15 years a pupil of PEURBACH. In intimate association and collaboration with his teacher during the last ten years of PEURBACH's life REGIOMONTANUS gained the necessary inspiration and equipment for the great labors that lay before him. In his extensive travels he made the acquaintance of the Italian astronomers as well as those of his own country. He was well versed in Greek and Latin and as early as 1464 he lectured on the Arabic astronomer AL-FERGANI. Indeed it was from Arabic sources that he drew most of his

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(1) CURTZE, « Ueber den DOMINICUS PARISIENSIS der *Geometria Culmensis* », *Bibliotheca Mathematica*, 1895, p. 107-110. CURTZE says : « The Practica Geometriæ reveals DOMINICUS as an able mathematician who for his time developed noteworthy accomplishments ».

(2) This table was not published because the more accurate table of REGIOMONTANUS appeared before PEURBACH's *Tractatus* went to press. (BRAUNMÜHL, p. 116.)

(3) CURTZE, « Ueber die Mittelalter zur Feldmessung benutzen Instrumenten », *Bibliotheca Math.*, 1896, p. 65-72.

knowledge of trigonometry (1). His short but very active career came to an end in 1476 while he was in Rome to reform the calendar for Pope SIXTUS IV.

We have already mentioned his construction of trigonometric tables (p. 304). To his *Tabulæ directionum* (2) is appended a table of sines to radius 60 000 for intervals of one minute. This we may consider as the forerunner of the popular 5-place tables of the nineteenth century. With the *Tractatus* GEORGII PURBACHII *super propositiones* PTOLEMÆI *de sinibus et chordis* which contains the familiar figure of AZ-ZARQALI and 6 propositions for finding the chord of any arc is commonly bound REGIOMONTANUS' *Compositio tabularum sinuum*. This work also contains 6 propositions : (I) Given the sinus of an arc, to find the sinus of its complement. (II) To find the sinus of arcs by kardagas. (III) The sinus of an arc ($< 90°$) is the mean proportional between $r/2$ and the sinus versus of twice the arc. (IV) To find the side of regular pentagon and decagon. This is followed by a table, for $r = 600\,000\,000$, of the 96 values of the sine that can be readily obtained by applying the preceding propositions. (V) To find the side of the quindecagon. (VI) Ordinates of equal arcs are farther apart toward the center of the circle. Then comes the table of sines for $r = 6\,000\,000$ followed by the table for $r = 10\,000\,000$, the interval in each case being one minute.

The first systematic treatise on trigonometry published in Europe is JOHANNES DE MONTEREGIO *de triangulis omnimodis libri quinque* (3). Of the five books the first two deal with plane and the last three with spherical triangles. Of the 57 propositions of book I the first 19 treat of proportion and the rest deal geometrically with the finding of unknown parts in right, isosceles, and scalene triangles. Following each proposition is an explanation of its use and often a numerical illustration is also given. Only in proposition 20 is there mention of a trigonometric function : « In any right triangle, if you describe from one acute angle a circle with the greatest side as radius the side

(1) BRAUNMÜHL concludes after careful examination of the matter that his sources were the works of AL-BATTANI, AL-FERGANI, AZ-ZARQALI and JABIR. (« NASSIR EDDIN TUSI und REGIOMONTAN », p. 38).

(2) Written about 1467 and published in 1490 by RATDOLT in Augsburg.

(3) Written about 1464 and published in Nuremberg in 1533. The *Compositio* was published there in 1541. The three works are in the University of Michigan library.

opposite this angle will be the sinus rectus of its arc; but the third side will be the sinus rectus of the complementary arc. » The first of the 33 propositions of book II is the sine law. The one figure and the proof resemble At-Tusi's given above (p. 312) but it has not been proved that the *Treatise on the Quadrilateral* was known to Regiomontanus. The statement and proof of proposition 25 follow.

« If in any triangle we know the base, the opposite angle and the perpendicular (altitude) or the area we shall at once know each of the sides. In the triangle *abg* (fig. 14) let the base *bg*, the perpendicular *ad*, or the area since the one depends on the other, and the angle *bag* be known. I say that we can know each of the sides. For let angle *bag* be obtuse and let the perpendicular from *b* meet *ga* produced at *k*. Then since angle *bak* is known the ratio of *ab* to *bk* is known by (blank) of this (book). But this ratio equals the ratio of *ab* times *ag* to *bk* times *ag*. Then since *bk* times *ag* is twice the area of triangle *abg* it is known and therefore the rectangle (product) of *ab* and *ag* is known. Now by the preceding proposition the diameter of the circumscribed circle is known from the perpendicular *ad* and the rectangle of *ab* and *ag*. Let the diameter *pq* meet the chord *bg* in *m* and let the radii *eg*, *ea* be drawn, as also *el* parallel to *bg* and meeting *ad* produced in *n*. Then *dn* equals *em* which is known from *eg*, *mg* and right angle *emg*. Hence *an* is known. Then *ne* is known from *an*, *ne* and right angle *ane*. Thus is known its equal *dm* and consequently the smaller segment *bd* which is the difference between *bm* and *dm* and the larger segment *dg* which is their sum are known. From these two segments and the perpendicular *ad* will be known the two sides » (1).

It is evident that Regiomontanus was interested in a unified basis and systematic arrangement of trigonometric theory with the object of making it useful to the astronomer. That he early saw the advantage of the tangent function is evidenced by the appearance in his *Tabulæ directionum* of a table of tangents for every degree from 0° to 90° with $r = 100\,000$. He called it the *tabula fœconda*, that is

(1) We can find *ab* and *ag* from the two equations $bg^2 = ab^2 + ag^2 - 2 \cdot ab \cdot ag \cdot \cos bag$, $ab \cdot ag \cdot \sin bag = ad \cdot bg$. The first implicit statement of the formula for the area of a triangle in terms of two sides and the sine of the included angle appears to be proposition 26 : « The area of a triangle and the product of two sides being known, either the included angle or its supplement will emerge ».

the *fruitful* (and therefore very useful) *table*, and the name was afterwards generally adopted to distinguish this table from the *tabulæ umbrarum*. The influence of REGIOMONTANUS' work on the progress of science was very great; his *De triangulis* ushered in a new era in the development of trigonometry.

JOHN DAVID BOND.

(Louisiana State University
Baton Rouge, La.)

Notes and correspondence.

The most important thing in the world. — From my point of view there are two things of immense importance in this world, two ideas or beliefs upon which, in the last analysis, the weal or woe of the race depends, and I am not going to say that belief in the possibilities of scientific progress is the most important. *The most important thing in the world is a belief in the reality of moral and spiritual values.* It was because we lost that belief that the world war came, and if we do not now find a way to regain and to strengthen that belief, then science is of no value. But, on the other hand, it is also true that even with that belief there is little hope of progress except through its twin sister, only second in importance, namely, belief in the spirit and the method of GALILEO, of NEWTON, of FARADAY, and of the other great builders of this modern scientific age, this age of the understanding and the control of nature, upon which let us hope we are just entering. For while a starving man may indeed be supremely happy, it is certain that he can not be happy very long. So long as man is a physical being, his spiritual and his physical well-being can not be disentangled. No efforts toward social readjustments or toward the redistribution of wealth have one thousandth as large a chance of contributing to human well-being as have the efforts of the physicist, the chemist, and the biologist toward the better understanding and the better control of nature. (1).

(UNIVERSITY OF CHICAGO.) R. A. MILLIKAN.

Classiques de la Science. — A plusieurs reprises (*Isis*, I, 99, 246, 476, 706; II, 125-161, 168-170), G. SARTON a parlé ici des collections des classiques de la science. Les lecteurs de langue française n'ont eu longtemps à leur disposition que les recueils de mémoires originaux, souvent difficiles à consulter, et non traduits. Enfin avait commencé à paraître, en 1913, à la librairie AD. COLIN, une collection des *Classiques de la science* (*Isis*, I, 706), dont les volumes se succèdent avec une lenteur désespérante : sept seulement ont vu le jour jusqu'à présent, dont les quatre premiers en 1913.

MAURICE SOLOVINE a commencé à faire paraître, en 1920, à la librairie

(1) From the address delivered by R. A. MILLIKAN at the National Museum, Washington D. C. on May 25, 1921, in connection with the presentation of a gram of radium to Mad. CURIE, as printed in *Science*, vol. 54, p. 1-8, July, 1921.

GAUTHIER-VILLARS & C^ie^, une collection des *Maîtres de la pensée scientifique* qui comprendra les mémoires et les ouvrages les plus importants de tous les temps et de tous les pays, et dans laquelle tous les domaines de la science seront représentés. Ont déjà été publiés, en petits volumes (180 × 115). HUYGENS : *Traité de la lumière* ; LAVOISIER : *Mémoires sur la respiration et la transpiration des animaux* ; SPALLANZANI : *Observations et expériences faites sur les animalcules des infusions* ; CLAIRAUT : *Eléments de géométrie* ; LAVOISIER ET LAPLACE : *Mémoire sur la chaleur* ; CARNOT : *Réflexions sur la métaphysique du calcul infinitésimal* ; D'ALEMBERT : *Traité de Dynamique* ; DUTROCHET : *Les mouvements des végétaux* ; *du réveil et du sommeil des plantes*.

Chacun de ces volumes comporte une notice biographique, un peu trop brève, à mon avis.

Sont annoncés des mémoires d'AMPÈRE, LAPLACE, GALILÉE, HERTZ, MARIOTTE, etc.

L. GUINET.

Collection des Mises au point. — Après les bouleversements causés par la guerre dans presque toutes les branches de la connaissance, un instant de recueillement est nécessaire si nous voulons arriver à saisir à quel point nous en sommes, quels sont les résultats acquis, tant au point de vue de la science pure que de la science appliquée.

Partant de cette idée, la librairie GAUTHIER-VILLARS & C^ie^ entreprend la publication d'une *Collection des Mises au point*, placée sous le patronage de l'industrie, et dans laquelle chacun des livres — il y en aura une vingtaine — rédigé par un spécialiste, répond à ces questions pour une science déterminée.

Chaque volume comprendra, d'après la notice de l'éditeur : 1° Un rappel des principes essentiels (anciens et nouveaux) ; 2° Un tableau assez détaillé de chaque science, l'historique de la science étudiée, l'enchaînement des méthodes, l'évolution des doctrines et des idées, et les perfectionnements des méthodes ; 3° Des conclusions générales sur l'extension de la science envisagée, les possibilités d'évolution des théories et principes, les principaux problèmes qui restent à résoudre et les perfectionnements à réaliser. Pour que ces mises au point restent ce qu'elles veulent être, des rééditions de chaque volume seront tenues à jour

J'ai sous les yeux un volume de cette collection, dû à L. DE LAUNAY, *Où en est la géologie*. Il est digne du but que se sont proposé les éditeurs ; il y manque cependant un index sommaire des principaux ouvrages et périodiques relatifs à la Géologie.

Ont également paru un volume traitant de la météorologie, de A. BERGET, et un autre pour l'astronomie, de l'abbé TH. MOREUX.

L. GUINET.

Reviews

Packard, Francis R. — *Life and times of* Ambroise Paré (1510-1590). With a new translation of his Apology and an Account of his Journeys in Divers Places, xii + 297 p., illustrated. New York, Paul B. Hoeber, 1921. [$ 7 50]

The distinguished editor of the *Annals of Medical History* is offering us a new account of the life of Ambroise Paré. He does not claim to have discovered any additional information but simply to tell afresh the facts which have been brought to light by Malgaigne (1840-1841) and Le Paulmier (1884) and told in English by Stephen Paget (1897). Dr Packard's account is clear and entertaining; the facts of Paré's life and his literary productions are introduced in one single chronological sequence. Then follows the translation of the racy autobiographical fragments which Paré published in 1585, in the fourth French edition of his collected works.

The moot question, whether Paré was a Huguenot or not, is discussed in a very judicial manner. In a memoir written by Paré in 1575 (and published by Le Paulmier) he stated himself that he belonged to « the Religion », but he was at any rate a very lukewarm Huguenot, who had many powerful friends at the Catholic court and was spared at the massacre of St. Bartholomew. As all that we know of him makes him appear a very pious and honest man, we must conclude that Paré was like Montaigne, Rabelais and Erasmus « au-dessus de la mêlée ». Possibly also his scientific curiosity and his professional duties engrossed him so much that there was no place left in his heart for religious fanaticism of any kind.

The book is splendidly got up. As a matter of fact I doubt whether such an expensive publication was entirely justified. It seems to me a little extravagant. There are many beautiful illustrations; but some are not strictly relevant (the two folded maps of Paris, for instance). I have noticed a number of misprints in the French and Italian phrases. Maybe some are sixteenth century misprints, but then the editor should have guarded himself by adding the word *sic*.

Such misprints (in the matter of accents, for example) are always irritating, but never more than in an edition de luxe : they look then like greasy spots on a wedding gown.

G. S.

Louis Dimier. — BUFFON, 308 p. Paris, Nouvelle librairie nationale, 1919.

Ce livre contient la matière des leçons données par l'auteur en 1918 à l'Institut d'Action Française à Paris. M. LOUIS DIMIER s'était donné pour tâche de réhabiliter BUFFON et cela est fort bien, car ce grand homme est injustement discrédité de nos jours. Mais il était possible de le réhabiliter sans insulter les Encyclopédistes. Détruire une injustice est une œuvre louable, mais remplacer une injustice par une autre, à quoi bon? — Quoi qu'il en soit, en dépit de son parti pris clérical ce livre est fort intéressant et se lit avec plaisir. Et j'ajouterai qu'il y a toujours du profit à lire des ouvrages dominés par des préjugés hostiles à ceux qu'on nourrit soi-même. — BUFFON était décidément un homme de l'ancien régime; il n'en avait pas les vices, mais il en avait toutes les qualités et les élégances; il était généreux et bon et l'on ne peut refuser son admiration à l'auteur de l'*Histoire naturelle*, un des plus grands monuments du XVIII^e^ siècle. Le livre de M. DIMIER est fort bien informé et nous raconte agréablement comment l'*Histoire naturelle* fut lentement édifiée par BUFFON et ses nombreux collaborateurs, savants et artistes. Par exemple, plus de quatre-vingts artistes furent employés continuellement pour les planches en couleurs. Il nous fait voir aussi la grande œuvre administrative de BUFFON, qui fut le vrai créateur du Museum. A ce propos il nous donne des renseignements fort intéressants sur les collections d'histoire naturelle existant à Paris. En 1787, il n'y en avait pas moins de quarante-cinq. L'auteur en conclut que la diffusion de la science était poussée plus loin au XVIII^e^ siècle que de nos jours : c'est là une conclusion bien hasardeuse. Il ajoute un peu plus loin (p. 181) : « Si le XVIII^e^ siècle fut le siècle de la science, il faut avouer que le XIX^e^ aura été celui de la pédanterie, etc ... » Il y a du vrai dans ces diatribes, mais elles n'en sont pas moins sectaires et injustes.

Les relations de BUFFON avec les Encyclopédistes donnent à M. DIMIER une excellente occasion de médire de ceux-ci. Encore une fois certains de ses reproches ne sont que trop fondés. Lorsqu'il signale les plagiats de l'Encyclopédie, par exemple, il fait chose utile. Il est certain que BUFFON n'aimait point les philosophes; il fréquentait le salon de M^me^ NECKER, et NECKER, adversaire de TURGOT, était leur ennemi. Cependant, BUFFON donna l'article « Nature » à l'Encyclopédie. M. DIMIER a un peu plus d'indulgence pour VOLTAIRE, et je veux citer

le passage suivant (p. 226), qui donnera une idée de sa manière : « Si parmi tant de négations détestables, il y eut chez VOLTAIRE un mérite, ç'aura été la persévérance, l'éloquence, les ressources d'invective et de satire avec lesquelles il combattit la bestialité de ROUSSEAU. Au milieu d'erreurs et de méchancetés sans nombre, VOLTAIRE fut un civilisé ; ROUSSEAU fut un sauvage. DIDEROT et ses pareils, contemplés de ce point de vue, apparaissent comme civilisés à peine, par l'idée ravalée qu'ils se faisaient de l'esprit, aussi bien que de l'effort humain : tout leur éloge des arts n'aboutissant qu'à l'apothéose des inventions ».

BUFFON était un grand seigneur, mais si le portrait de M. DIMIER est fidèle, c'était un homme aimable autant que grand. Il mourut en 1788 à la veille de la révolution, mais celle-ci causa la ruine de sa famille et son fils unique périt sur l'échafaud. On conçoit que M. DIMIER ait écrit avec joie un éloge qui lui permit de montrer l'ancien régime sous son aspect le plus séduisant. Comme il défend une cause perdue — car l'humanité ne revient jamais sur ses pas, — je lui pardonne volontiers son intolérance.

GEORGE SARTON.

W. A. Osborne. — WILLIAM SUTHERLAND. A biography, 102 p. Melbourne, The Lothian book publishing Co., 1920.

Dr. W. A. OSBORNE, professor of physiology at the University of Melbourne, has written this biography *con amore*, and it is doubly precious to us for it retraces the life of one who was at once a noble man and one of the first Australian scientists.

WILLIAM OSBORNE was born in Dumbarton, Scotland, on August 4, 1859. Both his parents were Scots; they were poor but gentle. The father was a woodcarver, and his specialty was the carving of figureheads for ships. They migrated to Australia in 1864, having at that time six children. They first went to Sydney, but in 1870 they moved to Melbourne where they finally settled down. WILLIAM gave signs promptly of his higher intellectual abilities and was educated at WESLEY College, later at Melbourne University (which was, in 1876, only twenty years old, a very small institution indeed, counting only 130 students, all boys). In 1880 he won the GILCHRIST scholarship for study in England. He arrived in London in the previous September, and it seems that his trip from Australia to the old world was his first contact with the uglier and ruder side of life, so well had he been thus far protected by the refined atmosphere of his home and of his university environment. He matriculated at University College, London, sat at the feet of RAY LANKESTER and CAREY FOSTER and won first class honours in experimental physics in 1881. On the whole his stay in England rather disappointed him, — he had become an Australian to the core — and

after five weeks of travel in France, Germany and Italy, he hastened to return to his beloved country.

His first scientific paper on « the mechanical integration of the product of two functions » was published in the *Philosophical Magazine* of August 1885; but his first paper of real importance appeared only a year later in the same journal. It deals with « the law of attraction amongst the molecules of gas ». He thus revealed from the beginning his bent towards molecular physics, to the study of which his whole life was to be devoted. In this paper SUTHERLAND showed that the molecules of a gas attract one another with a force inversely proportional to the fourth power of the distance between them, — a law which he applied later in 1893, to discover the true relation between viscosity and temperature. As this discovery will probably immortalize his name more than any other, it is well to explain it briefly. CLERK MAXWELL had stated in 1860 that, if the kinetic theory of gases was correct, the viscosity ought to be independent of the pressure. Experiments confirmed this. But MAXWELL had also stated that the viscosity should vary as the square root of the absolute temperature, and this was experimentally disproved. SUTHERLAND showed that the true relation was the one summarized in the formula:

$$\eta_t = \eta_0 \frac{273 + C}{\theta + C} \left(\frac{\theta}{273}\right)^{\frac{3}{2}}$$

wherein θ is the absolute temperature and C a constant (SUTHERLAND's constant). I can not describe SUTHERLAND's other investigations on such subjects as the nature of emulsion, the application of electrochemical ideas to the properties of matter, the molecular structure of water, etc. The reader will find a brief but sufficient treatment of these questions in OSBORNE's book. He will find in it also a list of SUTHERLAND's sixty-nine scientific papers with the corrections found in the author's own copies of them. Suffice it to say that most of them deal with molecular physics, and are chiefly theoretical, though SUTHERLAND took into account every available experimental datum. He himself did not conduct experiments, beyond a few very simple ones. It is probable that even if he had been able to avail himself of a well equipped laboratory, he would not have become a remarkable experimenter, for it is clear that he was not a born experimenter; he was essentially of a meditative nature.

This also explains why he could never be persuaded to accept a regular position. He was anxious to remain entirely free to follow his intellectual dream without restrictions of any kind. No amount of money could have compensated him for this loss of freedom. Hence he

did only such work as was necessary to provide for his very simple needs; he did some coaching and examining and wrote weekly articles for the Melbourne press. These articles were devoted either to popular explanations of the scientific problems of the day or to the disinterested discussion of current events. At a time when most men, small or big, poor or rich, seem always ready to prostitute themselves for a little more money, and have no time left for the only things which make life worth living, it is truly refreshing to meet a man like OSBORNE. «Sometimes — wrote he in 1886 — I regard myself as a very enviable creature, earning little enough it is true, but with no outside worries or duties — working away in the quiet house — working to a continual accompaniment of CHOPIN, SCHUBERT and BEETHOVEN.» Music was his main recreation and occasionally short walking trips in the Australian bush. SUTHERLAND was a man according to my own heart It is a pity, however, that he did not marry. As he lived with his brothers and sisters and had no establishment of his own, his material life was considerably simplified. But an unmarried philosopher can not be a complete philosopher. It is only when a man has to strive toward a high ideal and at the same time provide for the comfort and happiness of wife and children that the struggle becomes truly heroic and that we can judge him at his best.

WILLIAM SUTHERLAND died on October 5, 1911. We may properly conclude this review with the last words of his biographer: «Science, we all know, has had her martyrs. What we should realize with equal conviction, is that she has had her saints. And amongst the saints of science high place will assuredly be found for WILLIAM SUTHERLAND.»

GEORGE SARTON.

Was wir Ernst Haeckel verdanken. Ein Buch der Verehrung und Dankbarkeit. Im Auftrag des Deutschen Monistenbundes herausgegeben von HEINRICH SCHMIDT. Mit 12 Abbildungen, darunter 5 HAECKEL-Porträts. 2 Bände, 432 und 416 Seiten, Weltformat IX Leipzig, 1914, Verlag UNESMA.

Zur rechten Zeit ist dieses Buch erschienen, knapp vor Ausbruch des Krieges, der mit seinen Folgeerscheinungen die klare Atmosphäre wissenschaftlichen Urteils über Männer wie HAECKEL so sehr getrübt hat. Auch haben es die Nachkriegsverhältnisse mit sich gebracht, dass anlässlich des Todes des grossen Gelehrten (9. August 1919) weit weniger Urteile über ihn veröffentlicht wurden als bei früheren Anlässen, z. B. seinem achtzigsten Geburtstage, dem auch die vorliegende Festschrift galt. Sie orientiert reichlich, wenn auch nicht erschöpfend, von der einen Seite her — derjenigen seiner Freunde und Anhänger —

über des Gelehrten Lebenswerk. 123 Männer und Frauen aller Berufe, auch zahlreiche Ausländer, sprechen aus, welchen Gewinn ihnen und anderen HAECKELS Wirken gebracht habe, und man erhält ein glaubhaftes Bild von der grossen, geistigen Bewegung, welche durch ihn hervorgerufen beziehungsweise gesteigert wurde.

Als Einleitung schrieb der HAECKEL-Schüler H. SCHMIDT (Jena) eine interessante Abhandlung: sie stellt zunächst das Lebenswerk HAECKELS in den grossen Zusammenhang der kulturellen und geistigen Strömungen der Neuzeit und berichtet sodann nach sachlichen Gesichtspunkten über des Gelehrten Leben und Arbeit. Wieder wird seine ungeheure Arbeitsleistung auf systematisch-zoologischem Gebiete sowohl wie insbesondere für den Ausbau und die Anwendung der DARWINschen-Lehre aufgerollt; eine Leistung, die sich zu DARWINS Grundsätzen so verhält wie das Arbeitsprodukt zum Werkzeug. Denn der englische Gelehrte hatte *induktiv* gearbeitet und jene Forschungsgrundsätze geschaffen, die — nicht bloss bei HAECKEL und nicht bloss in der Biologie im engeren Sinne — ihre epochalen Wirkungen entfalten sollten. HAECKELS Stärke war die Deduktion und Synthese, gepaart allerdings mit schärfstem Blick für Tierformen und ihre Beziehungen, sowie mit einer seltenen Arbeitskraft. Sein künstlerischer Trieb nach Vollständigkeit der Lehre und des ganzen Weltbildes fand in DARWINS Ideen das geeignete Instrument; einmal (1860) erfasst, wirkten diese als Auslösung der einzigartigen Energie des 26jährigen Mediziners und inspirierten ihn zur Berufswahl und ganzen Arbeitsrichtung — durch ihn hunderte von Forschern, die unter seinen Einfluss traten und hunderttausende von Menschen, die er für den Darwinschen-Ideenkreis gewinnen sollte. Was der Wiener Zoologe B. HATSCHEK (II, 236) über ihn sagt: dass die meisten lebenden Zoologen als seine mittelbaren Schüler betrachtet werden könnten, ist für das deutsche Sprachgebiet sicherlich richtig; und dasselbe gilt von dem Ausspruch BAEGES (II, 153) die grosszügige freigeistig-kulturelle Bewegung Deutschlands in den letzten Jahren (vor dem Kriege) wäre ohne HAECKEL nicht möglich gewesen. — Die Gegenströmungen hat SCHMIDT nur insoweit berücksichtigt, als sie dem jungen HAECKEL galten, der sie so schneidig abwehrte; die scharfen Entgegnungen auf seine naturphilosophischen Schriften, insbesondere die verbreitetste von ihnen, *Die Welträtsel*, sind kaum gestreift, die heftigen persönlichen Angriffe gegen den greisen Forscher übergangen — obwohl letztere nicht gegen HAECKEL, sondern nur gegen seine Feinde sprechen. Vielleicht wäre es auch von einer ernsten wissenschaftlichen Darstellung nicht zuviel gefordert, die Irrtümer HAECKELS und seiner Freunde z. B. die Bathybius-Angelegenheit, zu erwähnen; das Gesamtbild hätte dadurch gewonnen.

Im Hauptteile folgen die Antworten der befragten Personen im ganzen

zufällig (in der Reihenfolge ihres Einlangens) aufeinander; man muss die Stimmen sichten, um einen reinen Eindruck zu erhalten. Im Vordergrunde steht begreiflicherweise die *Persönlichkeit* des Gelehrten. Den Auftakt gibt WILHELM OSTWALD, dessen Initiative das Buch zu verdanken ist. Er schildert HAECKEL als einen Mann "von einer geradezu rührenden Bescheidenheit und Bereitwilligkeit, sich beeinflussen zu lassen und seine Meinungen zu prüfen. . . . Die Art, wie er sich z. B. zu den wohlbekannten groben und über die sachliche Gegnerschaft weit hinausgehenden Angriffe CHWOLSONS äusserte, entsprach so sehr dem von dem Stifter des Christentums aufgestellten Ideal der persönlichen Milde auch den Feinden gegenüber, wie ich sie bei meiner mannigfaltigen Kenntnis von Geistlichen, theologischen Professoren, Priestern usw. niemals vorher bei den Dienern am Worte Gottes angetroffen hatte. Dieser unversöhnliche Gegner alles dogmatischen Christentums erwies sich als der beste und vorgeschrittenste „Christ", den ich je persönlich kennen gelernt hatte". In gleicher Weise findet sich der wissenschaftliche Gegner (SCHAXEL) nach dem Eindruck der Kämpfernatur, die aus HAECKELS Reden und Schriften spricht, von dessen persönlichem Wesen überrascht: „Bei grosser Bestimmtheit im eigentlichen Vortrag und im geschriebenen Wort oder gar in der öffentlichen Polemik zeigt er sich in der privaten Diskussion von einer überraschenden Bescheidenheit, von einer Zugänglichkeit für alle Einwendungen, die niemand erwartet, der ihn nur als Redner und Schriftsteller kennt." Wahrlich Beiträge zur Wesensschilderung des *modernen* Dogmatikers! Ein anderer wissenschaftlicher Gegner (BRUNNER) führt die Anerkennung, welche er trotzdem bei HAECKEL fand, auf dessen „grundgütiges" Menschentum zurück. Und immer wieder kehrt das Lob des „prächtigen, natürlichen, liebevollen Menschen" HAECKEL (WALTHER MAY).

Ueber HAECKEL *als Fachmann* spricht wieder OSTWALD das Leitmotiv: „Ich fand in ihm einen der reinsten und gleichzeitig edelsten Repräsentanten des romantischen Typus der Forscher". Für die Merkmale eines Romantikers, wie sie OSTWALD in dem Werke *Grosse Männer* aufgestellt hat, finden sich bei HAECKEL in der Tat stets neue Belege. Die grosse Geschwindigkeit der psychischen Reaktion wird aus mitgeteilten Gesprächen und Gelegenheitsreden deutlich. Die leidenschaftliche Begeisterung für das eigene Fach und die Gabe, sie anderen mitzuteilen, erhellt aus den Aussagen der durch HAECKEL persönlich dafür Gewonnenen (R. KELLER, RICH. HERTWIG, LEON u. a.). Der Romantiker ist ein guter, überzeugender und weite Wirkungen übender Lehrer — die fesselnden Schilderungen des Milieus an HAECKELS Lehrkanzel durch ANTIPA, LEEGE, SCHAXEL, VERWORN (weniger günstig: REH) erinnern deutlich an das Wirken eines anderen Romantikers, von dem

ein halbes Jahrhundert früher der Aufschwung der deutschen chemischen Forschung ausging, an LIEBIG. Wie LIEBIGS Schüler besetzen auch diejenigen HAECKELS eine grosse Zahl von Lehrstühlen im eigenen und Auslande und gründen so neue Zentren seines Einflusses; von ihnen kommen zu Worte RABL-Leipzig, (OSK. HERTWIG-Berlin). RICH. HERTWIG-München, FUERBRINGER-Heidelberg, LEON Jassy, ORTMANN-Pittsburgh. — Der Romantiker ist ein fruchtbarer Schriftsteller, streut reiche Anregungen aus und geht in seinem Eifer gelegentlich über das hinaus, was sich strenge aufrecht erhalten lässt; vielleicht war dieser Charakter unentbehrlich für die Aufstellung solcher Hypothesengebäude wie es HAECKELS Stammbäume waren; enthält doch sein Werk *Systematische Phylogenie* nach A. LANG (I. 135) über 600 solcher Hypothesen HAECKEL war überzeugt, damit eine notwendige und erspriessliche Arbeit zu leisten und seiner Meinung war auch HUXLEY, welcher schon 1869 über die *Natürliche Schöpfungsgeschichte* schrieb: „Mag man nun mit HAECKEL übereinstimmen oder nicht, so fühlt man doch, dass er das Denken in Bahnen gezwungen hat, in denen irrezugehen vorteilhafter ist als stillezustehen" (I, 103). — Mehrere Aeusserungen vervollständigen das Charakterbild des Forschers: seine „ausserordentliche Synthetisierungskraft" ANTIPA), das epochal wirkende Zurückdrängen der Detailfragen gegen die grossen, vom Darwinismus aufgeworfenen Grundfragen (R. HERTWIG), das grosse künstlerische Verständnis (Maler KOERNER), die Auswertung der Reisen, die ihn GOETHE und HUMBOLDT zur Seite stellt (WALTHER); u. dgl. m.

Der *Philosoph* HAECKEL und sein einschlägiges Hauptwerk *Die Welträtsel* (1899) begegnen auch hier verschiedener Beurteilung, wenngleich die unbedingten Anhänger überwiegen. Die Akademiker enthalten sich zumeist der Aussage, doch zeugen gelegentliche Bemerkungen einiger von ihrer ablehnenden Stellung; so sagt HATSCHEK bei aller begeisterten Anerkennung des Zoologen HAECKEL, dieser folge seinem ursprünglichen Hange zur Naturphilosophie vielleicht allzusehr; für W. MAY waren die *Welträtsel* geradezu Anlass zur Wiederabkehr von der Weltanschauung, die er aus der *Natürlichen Schöpfungsgeschichte* aufgenommen hatte. R. GOLDSCHEID berichtet von den scharf verurteilenden Worten des bekannten Philosophen PAULSEN und behauptet aus authentischer Quelle zu wissen, er habe sie später bereut. — Aus den meisten Urteilen spricht eine überströmende Dankbarkeit für die Befreiung vom Druck des Aberglaubens und die Einführung in die reiche Welt der Naturwissenschaft. Typisch ist z. B der Ausspruch von Dr HUSCHKE: „Man mag gegen dieses vielbefehdete und verketzerte Buch vorbringen, was man will . . . für mich ist es im höchsten Grade segensreich gewesen". In der Tat: der naturwissenschaftlich-gerichtete Kritiker mag den *naiven Realismus* HAECKELS als Philosophie ab-

lehnen — er wird ihm darum doch die grosse aufklärende Wirkung, die Beiseiteräumung sovielen mittelalterlichen Schuttes danken und die neue Welle der Begeisterung für die Wunder der Naturwissenschaft, im besonderen die erfolgreiche Bekämpfung der Indolenz gegenüber der Entwicklungslehre (RABL) als Kulturtaten grössten Stiles begrüssen. Mehrere Mitarbeiter wurden durch HAECKEL von unerträglichem Druck der Höllen- und Gespensterfurcht befreit — der Ausdruck „mein Erlöser" für den Gelehrten kehrt mehrmals wieder; ebenso sind die Bemerkungen typisch: „er hat meinem Leben Zweck und Inhalt gegeben" (SCHNEIDER, Bankbeamter); das Buch bedeutet „meine eigentliche Menschwerdung" (RIESS, Kaufmann); „dieser Lichtschimmer durch die Aufklärung war ein Wendepunkt in meinem Leben" (DOPF, Arbeiter); usw. *Die Welträtsel* waren bis 1913 in 310 000 deutschen Exemplaren verbreitet; aus dem englischen Sprachgebiet berichtet MCCABE (London), dass mehr als 250 000 Stück der Uebersetzung gekauft wurden.

Die grossen Kulturnationen sind sämtlich mit anerkennenden Aeusserungen über HAECKELS Lebenswerk vertreten; die Franzosen allerdings nur durch den französischen Schweizer Professor YUNG und durch den Brüsseler Prof. JOUSSET DE BELLESME. Der erstere berichtet über die starke Beeinflussung seiner jugendlichen Landsleute durch HAECKELS Bücher; der zweite schildert die Hindernisse, welche in Paris bis 1892 dem Entwicklungsgedanken bereitet wurden. Wenn er den geringen Einfluss HAECKELS in Frankreich auf das Joch eines alten theokratischen Atavismus zurückführt, von dem sich das Land trotz der Anstrengungen nicht befreien könne, so scheint dem doch einiges zu widersprechen und die Aeusserung bedürfte näherer Aufklärung.

Viele Beiträge bringen *autobiographisch Wertvolles*. WALTHER MAY schildert sein wechselvolles Leben, der Anatom FUERBRINGER seine unter HAECKELS Zeichen stehende Laufbahn; R HERTWIG berichtet, wie er und sein Bruder OSKAR, ursprünglich zu Chemikern bestimmt, durch HAECKELS Persönlichkeit für die Zoologie gewonnen wurden; ähnlich der russische Musiker DAVIDOFF.

Endlich lernt man aus dem Buche auch den *Deutschnationalen* HAECKEL kennen, welcher am Geburtstage seines Grossherzogs in malerischer Tracht zur Gratulation antritt, und der die Initiative zu einer besonderen Ehrung BISMARCKS durch die Jenaer Universität ergreift. Der Wiener Soziologe GOLDSCHEID berichtet hingegen, wiesehr noch der greise Forscher als Ehrenpräsident des „Monistenbundes" von alten Ansichten abrückte, und heute kann darauf verwiesen werden, dass diese grösste Vereinigung von Freidenkern in ihren Publikationen eine entschieden kriegsgegnerische, völkerversöhnende Tendenz ver-

folgte. Möge diese vor dem Kriege gestreute Saat in der Nachkriegszeit, die ihrer Früchte sosehr bedürftig ist, reich aufgehen und dem gegenseitigen Verständnis bei der Beurteilung auch dessen, was im Kriege geschah, den Weg bereiten.

(Brünn, Mähren.) ERNST BLOCH.

B. Lepsius. *Deutschlands Chemische Industrie 1888—1913.* 108 S in-8°. Berlin, GEORG STILKE, 1914.

Der Aufschwung der deutschen Industrie während der Regierungszeit WILHELMS II. ist eine Tatsache von so grosser geschichtlicher Bedeutung und derjenige der chemischen Industrie in diesem Rahmen ein so typisches Beispiel, dass die vorliegende Monographie dauernden Wert besitzt, obgleich sie aus einem Gelegenheitswerke stammt und unter dem Zeichen einer Geschichtsbetrachtung steht, die man als überwunden ansehen darf. Das Buch ist ein neubearbeiteter Beitrag zu einem Sammelwerke „Soziale Kultur und Volkwohlfahrt während der ersten 25 Regierungsjahre Kaiser WILHELM II". Nach einem längeren Exkurs in die Vorgeschichte wird das Gesamtgebiet der chemisch-industriellen Praxis des Vierteljahrhunderts durchschritten, die wichtigsten in Deutschland aufgefundenen Verfahren nach ihrer Entstehungsgeschichte geschildert, jeder Industriezweig an der Hand einer Fülle statistischer Daten in seiner Entwicklung verfolgt. Obwohl sich in dem Buche kaum prinzipiell Neues findet, wird doch das gedrängte Bild der innigen Verflechtung von Wirtschafts- und Geistesgeschichte sowie des Standes der angewandten Chemie im beginnenden zwanzigsten Jahrhundert auch dem Fachmann von Bedeutung sein.

(Brünn, Mähren.) ERNST BLOCH.

Sir John Edwin Sandys. *A history of classical scholarship.* Vol. I. From the VIth century B. C. to the end of the Middle Ages. Third edition. XXIV + 702 p., 24 illustr. Cambridge University Press, 1921.

The first edition of this volume appeared in 1903, and a second edition of it was called for in 1906, that is, before the completion of the work. Volumes II and III were published in 1908 and a complete summary of the whole work (A short history etc.), in 1915. As the author points out (p. 13), a knowledge of the history of classical scholarship « is indispensable to the student, and even to the scholar, who desires to make an intelligent use of the leading modern commentaries on classical authors which necessarily refer to the labours of eminent scholars in bygone days. And the study of that history is not without its in-

cidental points of interest, in so far as it touches on themes of such variety, and such importance, as the earliest speculations on the origin of language, the growth of literary and dramatic criticism at Athens, the learned labours of the critics and grammarians of Alexandria and Rome, and of the lexicographers of Constantinople. It has also its point of contact with the scholastic philosophy of the Middle Ages, with the revival of learning and the reformation of religion, and with the foundations of the educational systems of the foremost nations of the modern world » The subject has been divided into six sections (the dates are only approximate): (1) The Athenian age, from 600 to 300 B. C.; (2) The Alexandrian age, from 300 to the beginning of the Christian era; (3) The Roman age of Latin scholarship from 168 B. C. to 530 A. D.; (4) The Roman age of Greek scholarship from the beginning of the Christian era to 530 A. D.; (5) The Byzantine age, or the Middle Ages in the East, from 530 to 1350 A. D.; (6) The Middle Ages in the West, from 530 to 1350 A. D. It is out of the question to attempt a further summary of a work containing an enormous amount of information in a highly compressed form. Suffice it to say that it is exactly what we would wish such a work to be: it is accurate, clear, complete, yet never dull. A very pleasant feature is the insertion of twelve chronological tables which enable the student to take a bird's eye view of the development of scholarship at any given period.

The text of this third edition is substantially the same as that of the second but the author has submitted the whole volume to a careful revision. Special advantage was taken of LUDWIG TRAUBE's posthumous *Vorlesungen und Abhandlungen*, Munich 1909—1911, of KARL MANITIUS' *Geschichte der lateinischen Literatur des Mittelalters*, Bd. 1, Munich, 1911 and of REMIGIO SABBADINI's *Le scoperte dei codici latini e greci*, vol. 2, Firenze 1914.

At a time when publishers are becoming more and more expert in the art of making a leaflet look like a grownup book and of selling it as such, it is a real comfort to get hold of a volume as compact and substantial as SANDYS' history. Praise to the Cambridge University Press!

G. SARTON.

Max C. P. Schmidt. *Kulturhistorische Beiträge zur Kenntnis des griechischen und römischen Altertums*. Erstes Heft: Zur Entstehung und Terminologie der elementaren Mathematik. Zweite verbesserte Auflage, XVI + 269 S. Leipzig, DUERR, 1914. Zweites Heft: Die Entstehung der antiken Wasseruhr, 113 S. Leipzig, DUERR, 1912.

MAX C. P. SCHMIDT is widely known as the author of a *Realistische Chrestomathie aus der Literatur des Klassischen Altertums* (1), that is,

(1) In three vol. Leipzig, DUERR, 1900—1901. Vol. I deals with mathematics; vol. II, with astronomy and geography; vol. III, with physics and technology.

a collection of Greek and Latin texts illustrating ancient science. From the beginning, his interest in Greek and Latin literature has been that of a true humanist, to whom no aspect of intellectual progress is indifferent. The two collections of learned monographs now under review afford further proof, if such were needed, of his deep interest in ancient science and technology. He tells us that his original aim was to write a history of Greek culture, but that he soon realized that such a history could not be satisfactorily written until a large amount of additional research had been accomplished. It was necessary to determine, for instance, the development of physical knowledge, the formation of geometrical ideas and propositions, the identification of ancient names of plants and animals with the modern ones, the signification and extent of Greek technology. It was equally indispensable to reach more definite conclusions on the relations between Greek civilization and the Mycenean and Oriental civilizations. He was thus obliged to change his plans, and, instead of writing a comprehensive history, to undertake many special investigations. It is the results of these patient investigations that he is now offering us, to be used as materials for the historical synthesis of his dreams, when the time comes to build it.

The philological point of view is fundamental throughout the book, but Prof. SCHMIDT never forgets the reality which our words, however ancient they be, are meant to represent. He has tried to round out every topic which he has touched as completely as possible. His book is thus an incomplete collection of finished fragments.

The first volume dealing with the formation and terminology of elementary mathematics contains an introduction of 56 p., wherein he studies mathematical terminology in general, also the Greek concept of elementary mathematics and the influences to which early mathematics was subjected (in two chapters respectively entitled: Nil, Euphrat, Indus — Milet, Ephesos, Samos; SCHMIDT's conclusions are very conservative; he does not deny the possibility of Oriental influences, but considers them as entirely unproved, except as far as the initial stimulation received from Egypt is concerned). Then follows a series of philological monographs which I will simply enumerate: Punkt, Linie, Gerade, Fläche, Ebene, Grenze, Winkel. — THALES. — Lineal und Richtschnur, Lotstift und Lotschnur, Winkelmass und Zirkel. — PYTHAGORAS. — Die Seitenharmonie des PYTHAGORAS. — Herkunft des Wortes Hypotenuse. — Herkunft des Wortes Kathete. — Herkunft des Wortes Peripherie. — EUKLID. — Das Rechnen bei den Griechen. — Das Rechnen bei den Römern. — Herkunft des Wortes Summe. — Zur lateinischen Terminologie der elementaren Arithmetik.

The author's main conclusion is tersely expressed as follows: *Ex*

oriente lux, ex occidente lex. The initial ferment came from the East; the elaboration and codification took place in the West. It is very typical that our geometrical terminology is mainly of Greek origin, while our arithmetical words are mostly Latin; this may be taken as a good example of the sort of historical information crystallized in our language. The word algebra is Arabic, and that also is a tell-tale.

The second volume is more homogeneous, or at least has a more orderly appearance. It is entirely devoted to the ancient waterclock, the story of which is told in chronological sequence: (1) Introduction; (2) Description and history of the ancient clepsydra. Period of Dorian-Ionian philosophy; (3) Period of Attic logography; (4) Alexandrian and Roman period; (5) Conclusion.

Both volumes are divided into three main parts: the memoirs, the notes and the documentary texts (chiefly Greek). The first volume contains 65 p. of texts, the second, 30 p. The texts quoted in the latter are divided into four sections: the clepsydra as an observation instrument; the clepsydra as a clock; the clepsydra in Alexandrian and Roman times; ancient waterclocks. GEORGE SARTON.

Paul Tannery. Mémoires scientifiques publiés par J. L. HEIBERG et H. G. ZEUTHEN. III. *Sciences exactes dans l'antiquité*, 3me volume (1899-1913), XV + 419 p. Toulouse, EDOUARD PRIVAT, 1915.

Les deux premiers volumes de l'admirable monument élevé à PAUL TANNERY par la piété de sa veuve ont été analysés dans *Isis*, I, p. 114-115, 509-512. Ces deux volumes, parus en 1912, contenaient soixante-cinq notes et mémoires relatifs aux sciences exactes dans l'antiquité classique, publiés de 1876 à 1898. Le troisième volume, qui contient vingt-cinq mémoires publiés de 1899 à 1913, complète la section de l'ouvrage relative à l'antiquité. Une analyse détaillée de ces mémoires prendrait trop de place; je dois me borner à les énumérer en intercalant quelques brèves remarques qui permettent au lecteur averti de se rendre compte du contenu de chacun d'eux. Toutefois, au lieu de signaler ces mémoires dans l'ordre où ils sont publiés, je les ai classés chronologiquement, conformément à la méthode d'*Isis*.

S. V. A. C.

A propos des fragments philolaïques sur la musique (p. 220-243). *Revue de philologie*, t. 28, p. 233-249, 1904. « En résumé, je serais porté à croire qu'en ce qui concerne les intervalles mélodiques, la musique grecque a subi dans les sept siècles de PYTHAGORE à PTOLÉMÉE une évolution sur laquelle les théories n'ont exercé qu'une influence d'autant plus faible qu'elles ont suivi les faits au lieu de les régler.

De ces théories, celle d'ARISTOXÈNE est restée lettre morte ; la lutte a existé en réalité entre deux écoles qui remontent l'une à PLATON (celle des canoniciens classiques), l'autre à ARCHYTAS ».

S. IV. A. C.

Sur les problèmes attribués à ARISTOTE (p. 32-36). *Annales internationales d'histoire*, 5me section. « Histoire des Sciences » 108-111. (Remarques faites au Congrès de Paris, 1900, à propos du travail de MAURICE GALLIAN.)

Y a-t-il un nombre géométrique de PLATON ? (p. 188-195). *Revue des études grecques*, t. 16, p. 173-179, 1903.

Sur un point d'histoire de la musique grecque (p. 90-96). *Revue archéologique*, t. 39, p. 49 54, 1902 — A propos d'un passage du περὶ μουσικῆς de PLUTARQUE. Ce texte, « en établissant, dès l'époque d'ARISTOXÈNE, l'altération des sons dits fixes, permet de supposer que les tonalités de notre mode majeur étaient dès lors introduites ; la même supposition peut naturellement être faite pour le mode mineur, qui n'entraînait qu'une altération des sons mobiles ».

Sur le spondiasme dans l'ancienne musique grecque (p. 299-309). *Revue archéologique*, t. 1, p. 41-50, 1911.

Un traité grec d'arithmétique antérieur à EUCLIDE (p. 244-250). *Bibliotheca mathematica*, t. 6, p. 225-229, 1905. A propos d'un fragment d'ARCHYTAS conservé par BOÈCE. Le mémoire de 1904 sur les fragments philolaïques, cité plus haut, se rapporte aussi en grande partie à ARCHYTAS.

EUDOXE (p. 366-369). Article de la *Grande Encyclopédie* (c. 1893).

S. III A. C.

Inauthenticité de la « Division du canon » attribuée à EUCLIDE (p. 213-219). *Comptes Rendus de l'Académie des inscriptions*, t. 4, p. 439-445, 1904.

EUCLIDE (p. 362-366).	Article de la *Grande Encyclopédie*	(c. 1893).
Porisme (p. 374-377).	*Idem.*	(c. 1900).
APOLLONIUS (p. 322-325).	*Idem.*	(c. 1887).
ARCHIMÈDE (p. 326-329).	*Idem.*	(c. 1887).
CONON (p. 353-354).	*Idem.*	(c. 1891).
ERATOSTHÈNE (p. 358-362).	*Idem.*	(c. 1893).

S. II A. C.

L'invention de l'hydraulis (p. 282-298). *Revue des études grecques*, t. 21, p. 326-340, 1908. (Mémoire inachevé complété par une note du baron CARRA DE VAUX.)

S. I A. C.

Le philosophe AGANIS est-il identique à Geminus? (p. 37-41, 379.) *Bibliotheca mathematica*, t. 2, p. 9-11, 1901.

Compte rendu du t. III des œuvres de HÉRON D'ALEXANDRIE, édité par HERMANN SCHÖNE (p. 131-157). *Journal des Savants*, p. 147-157, mars 1903 et p. 203-211, avril 1904.

Notes critiques sur les *Metrica* de HÉRON (p. 196-207). *Revue de philologie*, t. 28, p. 181-188, 1904.

CLÉOMÈDE (p. 351-353). Article de la *Grande Encyclopédie* (c. 1891).

S. I.

Sur la sommation des cubes entiers dans l'antiquité (p. 116-118). *Bibliotheca mathematica*, t. 3, p. 257-258, 1902. (Se rapporte à la proposition de NICOMAQUE qui est probablement plus ancienne.)

ANATOLIUS sur la décade et les nombres qu'elle comprend (p. 12-31). *Annales internationales d'histoire*, 5e section, p. 42-57. Congrès de Paris, 1900. (Suivi de deux appendices publiés en 1899 et 1905.)

ANATOLIUS d'Alexandrie (p. 321-322). Article de la *Grande Encyclopédie* (c. 1887).

Note sur le problème de PAPPUS (p. 42-50). Extrait des œuvres de DESCARTES publiées par ADAM et TANNERY, t. 6, p. 721-725, 1902.

DIOPHANTE (p. 355-358). Article de la *Grande Encyclopédie* (c. 1892).

S. V.

Le manuel d'introduction arithmétique du philosophe DOMNINOS de Larissa (p. 255-281). *Revue des études grecques*, t. 19, p. 360-382, 1906. (traduction et commentaire).

Note sur *Anonymi fragmentum de revolutionibus lunae* publié par Ch. E. RUELLE (p. 310-311). *Catalogus codicum astrologorum graecorum*, t. 8, p. 125, Bruxelles, 1911. (Ce texte avait été publié *ibidem*, p. 126-134.) « Il semble impossible de faire descendre ce fragment jusqu'à l'époque de THÉODORE DE MELITÈNE (*i. e.*, c. 1361), car il ne renferme aucun indice de connaissance de l'astronomie persane ou arabe... ; la langue et la valeur du fragment permettent bien plutôt de le faire remonter au Ve ou VIe siècle. »

S. VI.

SIMPLICIUS et la quadrature du cercle (p. 119-130). *Bibliotheca mathematica*, t. 3, p. 342-349, 1902.

Astronomie.

Le Cadran de Carthage (p. 1-11). *Comptes rendus de l'Académie des Inscriptions*, t. 27, p. 38-48, 1899. A propos du cadran plan du Musée des Pères Blancs à Carthage, différent des cadrans solaires grecs analogues.

Astronomie (p. 335-351). Article de la *Grande Encyclopédie* (c. 1887). (Brève histoire de l'astronomie.)

Mathématiques.

Du rôle de la musique grecque dans le développement de la mathématique pure (p. 68-89). *Bibliotheca mathematica*, t. 3, p. 161-175, 1902.

Notions historiques (p. 158-187). Extrait des Notions de Mathématiques de JULES TANNERY, p. 322-348, Paris, 1903. Brèves notes d'histoire sur les sujets suivants: 1. Origines de l'algèbre. — 2. Sens des mots analyse et synthèse chez les Grecs et leur algèbre géométrique. — 3. Quantités positives et négatives. — 4. Courbes étudiées par les anciens. — 5. Origine de l'emploi des coordonnées pour la représentation graphique de la variation des phénomènes. — 6. Origines du calcul infinitésimal.

Symbole de soustraction chez les Grecs (p. 208-212). *Bibliotheca mathematica*, t. 5, p. 5-8, 1904.

Trois manuscrits grecs mathématiques de Turin (p. 251-254). *Revue des études grecques*, t. 18, p. 207-210, 1905.

Arithmétique (p. 330-335). Article de la *Grande Encyclopédie* (c. 1887).
Géométrie (p. 370-374). *Idem.* (c. 1894).
Porisme (p. 374-377). *Idem.* (c. 1900).

Musique.

Plusieurs mémoires cités plus haut se rapportent à la musique grecque (ARISTOXÈNE, ARCHYTAS, EUCLIDE). Voir par exemple le premier mémoire du paragraphe précédent.

Sur les intervalles de la musique grecque (p. 97-115). *Revue des études grecques*, t. 15, p. 336-352, 1902.

L'évolution des gammes antiques (p. 312-320). Œuvre posthume inédite publiée par les soins de Th. REINACH, suivie d'une lettre à EDMOND GOBLOT (1896) sur la musique grecque (reproduite en fac-similé).

Physique. Métrologie.

MENSURA (μέτρον, mesure) (p. 51-67). Article du *Dictionnaire des antiquités grecques et romaines* de DAREMBERG et SAGLIO, t. 3, p. 1727-1731, 1902.

Ce volume est orné d'un portrait de TANNERY lycéen en 1859 (un crayon d'ARMAND BERTON d'après une photographie) et il se termine par un copieux index des tomes I à III.

G. S.

Paul Tannery. Mémoires scientifiques publiés par J. L. Heiberg. IV. *Sciences exactes chez les Byzantins* (1884-1919), xv + 442 p., 9 planches. Toulouse, Edouard Privat, 1920.

Pour ce qui concerne les trois volumes précédents, voir plus haut mon compte rendu du t. III. Je me propose d'analyser le volume IV en suivant la même méthode. Ce volume est d'un intérêt peut-être encore plus grand que les précédents, car tandis que la science grecque commence à être assez bien connue, la science byzantine a encore tout le mystère et le charme des domaines à peine explorés.

S. VI.

Notes critiques sur le traité de l'astrolabe de Philopon (p. 241-260). *Revue de philologie*, t. 12, p. 60-73, 1888. Ce traité a été publié par H. Hase dans le *Rheinisches Museum* de 1839, p. 127-171, mais cet éditeur n'en a pas bien compris toute l'importance. Si l'on tient compte de ce que le Planisphère de Ptolémée est un ouvrage purement théorique, le traité de Jean d'Alexandrie, dit Philopon, est le premier qui ait été consacré à l'astrolabe et le seul qui nous soit parvenu de l'antiquité. L'instrument décrit par Philopon (ἀστρολάβος) était déjà aussi perfectionné qu'il l'a jamais été par les Arabes.

S. XI.

Psellus sur la grande année (p. 261-268) *Revue des études grecques*, t. 5, p. 206-211, 1892. — Les chiffres donnés par Psellus dans sa Διδασκαλία παντοδαπή (éd. Fabricius, 1712) dérivent sans doute de la Syntaxe de Ptolémée.

Psellus sur les nombres (p. 269-274). *Ibidem*, t. 5, p. 343-347, 1892. Texte inédit περὶ ἀριθμῶν tiré d'un MS. de l'Escorial. Ce texte est une analyse ou un résumé des trois livres (V, VI, VII) que Jamblique avait consacrés à la Physique, à l'Ethique et à la Théologie dans son grand ouvrage sur la secte pythagorique dont il ne nous reste que les quatre premiers livres.

Psellus sur Diophante (p. 275-282), *Zeitschrift für Mathematik und Physik, Hist. Liter. Abt.*, t. 37, p. 41-45, 1892. Fragment inédit tiré de MSS. de l'Escorial et de la Laurentienne. La méthode algébrique de Diophante y est étrangement appelée analyse égyptienne (ἡ κατ Αἰγυπτίους μέθοδος, ἡ Αἰγυπτιακὴ ἀνάλυσις). Diophante est antérieur à Anatolius.

S. XII.

Theodore Prodrome. Sur le grand et le petit (A Italicos). Texte grec inédit et notice (p. 207-222). *Annuaire de l'Association pour l'encou-*

ragement des études grecques en France (p. 104-119, 1887). PRODROME, écrivain et commentateur d'ARISTOTE, vivait au début du XII^e^ siècle Le texte édité par TANNERY et tiré de MSS. de la Bibliothèque nationale est consacré à réfuter un passage des Catégories où ARISTOTE a placé le grand et le petit, le beaucoup et le peu dans la catégorie du πρός τι et non pas du ποσόν, où il a nié que ces termes fussent respectivement contraires entre eux.

S. XIV.

MANUEL MOSCHOPOULOS et NICOLAS RHABDAS (p. 1-19). *Bulletin des sciences mathématiques*, t. 8, p. 263-277, 1884.

Le traité de MANUEL MOSCHOPOULOS sur les carrés magiques. Texte grec et traduction (p. 27-60). *Annuaire de l'Association pour l'encouragement des études grecques*, p. 88-118, 1886. Ce texte a été publié pour la première fois par SIEGMUND GÜNTHER (*Vermischte Untersuchungen zur Geschichte der mathematischen Wissenchaften*, Leipzig, p. 195-203, 267-268, 1876), mais d'après un mauvais MS. de Munich. Ce traité a dû être écrit au début du XIV^e^ siècle; il est dédié à RHABDAS; c'est le plus ancien document connu de la tradition grecque sur les carrés magiques, tandis que ceux-ci étaient déjà connus par les Arabes au X^e^ siècle. Furent-ils découverts par les Arabes? Le traité de MOSCHOPOULOS ne décèle aucune influence arabe. Le texte publié par TANNERY est basé sur un MS. de la Bibliothèque nationale.

Notice sur les deux lettres arithmétiques de NICOLAS RHABDAS. Texte grec et traduction (p. 61-198). *Notices et extraits de la Bibliothèque nationale*, t. 32, p. 121-252, 1886.

Astronomie.

Les noms de mois attiques chez les Byzantins (p. 222-239). *Revue archéologique*, t. 9, p. 23-36, 1887.

Les éphémérides chez les Byzantins (p. 289-293). *Bulletin des sciences mathématiques*, t. 30, p. 59-60, 1906.

Mathématiques.

Le scholie du moine NÉOPHYTOS sur les chiffres hindous (p. 20-26). *Revue archéologique*, t. 5, p. 99-102, 1885.

Les chiffres arabes dans les manuscrits grecs (p. 199-205). *Ibidem*, t. 7, p. 355-360, 1885.

Le calcul des parties proportionnelles chez les Byzantins (p. 283-287). *Revue des études grecques*, t. 7, p. 204-208, 1894.

Chiffres, histoire (p. 413-421) Article de la *Grande Encyclopédie*, vers 1891.

Superstitions médiévales

Le Rabolion (œuvre posthume). Traités de géomancie arabes, grecs et latins (p. 295-411). — La géomancie est un procédé de divination à l'aide de sable (on marque des points au hasard sur une surface de sable et on interprète les figures formées par ces points. Je n'indique que le principe ; l'opération même est assez compliquée). Cette superstition est d'origine arabe. Les Arabes appelaient la « science du sable » *raml* d'où dérive le mot byzantin ῥαβδόλιον. Quant au mot *geomantia* (γεωμαντεία) il n'a été découvert dans aucun texte grec ancien ; on le trouve pour la première fois dans un fragment de VARRON cité par ISIDORE DE SÉVILLE (*Etym.*, VIII, 9, 13). TANNERY émet l'hypothèse que ce mot fut employé pour la première fois pour désigner le *raml* par HUGO SANCCELLIENSIS, un des traducteurs de l'arabe en latin. Si comme le dit TANNERY, HUGO vivait vers le milieu du XII^e^ siècle, son traité de géomancie serait le plus ancien de l'Occident (1). L'étude de la géomancie dérive la plus grande partie de son intérêt du fait qu'elle nous donne l'occasion de comparer des développements contemporains arabes, byzantins et latins. Le grand mémoire (en partie inachevé) de TANNERY se compose de quatre parties : la première due au baron CARRA DE VAUX est un examen de la géomancie arabe (avec reproduction fac-similé de trois talismans arabes) ; la seconde contient des études sur l'histoire du mot *géomancie*, le traducteur HUGO SANCCELLIENSIS, l'*Ars geomantiae*, la *Geomantia nova* et la technique de la géomancie ; la troisième relative à la géomancie byzantine, nous donne le texte de deux MSS. grecs de la Bibliothèque nationale ; la quatrième relative à la géomancie occidentale, contient le texte de deux MSS. latins, l'un de la Bibliothèque nationale, l'autre de la Laurentienne.

Je dois encore citer, pour compléter cette analyse, une note « sur le projet d'un Corpus des humanistes byzantins » (p. 422-428). C'est le projet formulé d'abord par LUDWIG STEIN au Congrès d'histoire de Rome en 1903. A-t-il reçu un commencement d'exécution ? Il y aurait sans doute un très grand intérêt à rassembler les textes (2) de la grande renaissance byzantine qui, provoquée par le sac de Constantinople par les Croisés en 1204, s'accusa vers le milieu du XIII^e^ siècle et s'épanouit au XV^e^, au moment même où la civilisation byzantine va succomber devant l'islamisme. PAUL TANNERY préparait lui-même l'édition du traité de GEORGES PACHYMÈRE (1242-1310) sur les quatre

(1) WÜSTENFELD rangeait HUGO arbitrairement parmi les traducteurs du XIV^e^ siècle (*Die Uebersetzungen arabischer Werke*, p. 120-121, 1877).

(2) Il faudrait les cataloguer tous avec résumés et extraits étendus et publier les principaux *in extenso*.

sciences (sauf la musique déjà publiée). Il écrivait à DIELS en 1886 qu'il avait déjà 450 pages de texte grec prêtes pour l'impression. Qu'est devenu ce travail ? G. S.

Raphaël Petrucci († 1917). *Kiai Tseu Yuan Houa Tchouan*. Les enseignements de la peinture du jardin grand comme un grain de moutarde. Encyclopédie de la peinture chinoise. Traduction et commentaires, augmentés d'une préface, d'un dictionnaire biographique des peintres et d'un vocabulaire des termes techniques. In-f°, XII+519 p., env. 500 grav. Paris, HENRI LAURENS, 1918. [300 fr.]

Le sous-titre donné par le très regretté PETRUCCI à la traduction de cet ouvrage n'est pas du tout une exagération, car le *Kiai tseu yuan houa tchouan* constitue une véritable encyclopédie de la peinture chinoise. L'historien de la pensée asiatique le lira avec beaucoup d'intérêt, car le texte nous révèle à tout moment des aperçus nouveaux sur les conceptions que les Chinois se font de l'univers. Certaines de ces conceptions ont une base scientifique, d'autres sont purement magiques (par exemple les idées sur le regard, à propos de la peinture des yeux). L'ouvrage nous donne le résultat d'études analytiques poursuivies pendant des siècles avec un bon sens et une méthode admirables ; — bien souvent elles évoquent celles entreprises par LÉONARD DE VINCI, et le fait que nous ne trouvions pas d'autre point de comparaison en Occident est significatif. Mais aux résultats de ces recherches positives sont inextricablement mêlées des conceptions philosophiques — taoïstes et bouddhistes ou plus anciennes encore — qui donnent au livre une saveur étrange, comparable à celle que nous inspirent les vieilles peintures chinoises elles-mêmes. Rappelons-nous à ce propos que l'œuvre de LÉONARD est elle aussi saturée de pensées médiévales, que lui aussi ne peut s'empêcher de comparer sans cesse le macrocosme et le microcosme et que pour lui tout autant que pour l'artiste chinois la montagne était une chose vivant d'une vie cachée : l'eau circulant à l'intérieur étant comme le sang qui se meut dans notre corps. Le premier livre est tout particulièrement intéressant. Il nous offre d'abord un résumé de l'esthétique chinoise : nous y retrouvons, par exemple les six principes énoncés par SIE HO au V^e^ siècle, éclairés cette fois par un admirable commentaire de PETRUCCI. Ensuite une série de chapitres sur les encres, les couleurs, les procédés d'atelier, les papiers, les soies nous permettent d'apprécier l'évolution des arts et métiers en Chine. (La troisième partie du livre IX doit être rapprochée de la fin de l'introduction, qu'elle complète et corrige.)

Le *Kiai tseu yuan houa tchouan* dans sa forme actuelle date de la fin

du XVII[e] siècle. L'édition princeps de la première partie date de 1679, celle de la seconde partie parut en 1701 (1). Mais les éléments en sont beaucoup plus anciens, car cet ouvrage n'est en somme qu'une codification de la tradition chinoise. Le premier noyau de l'ouvrage fut constitué par un ensemble de planches relatives au dessin du paysage accompagnées d'un texte explicatif par le peintre LI TCH'ANG HENG (ou LI LIEOU-FANG, né à Kia-ting en 1575, mort en 1629). Cet album faisait partie des collections de CHEN SIN-YEOU (appellation, YIN-PO), le possesseur du jardin *Kiai tseu* (duquel notre ouvrage dérive son nom) à Nankin. Grâce à ses efforts et à ceux de son beau-père LI YU, le *Kiai tseu yuan* devint un véritable centre de publications d'art. Ce LI YU (appellation, LI-WONG) était un écrivain et un critique, il vivait à la fin du XVII[e] siècle et au commencement du XVIII[e]. C'est à lui et à CHEN SIN-YEOU que nous devons la rédaction du *Kiai tseu yuan houa tchouan*. Ils se firent aider des trois frères WANG, artistes et archéologues distingués : le plus jeune, WANG YE (appellation, SSEU-TCHE); WANG NGAN-TSIE (aussi appelé LOU-TCH'AI); l'aîné, WANG CHE (appellation, FOU-TS'AO). La seconde partie (livres VI à XI) fut rédigée avec la collaboration des deux peintres WANG YUN-NGAN et TCHOU CHENG (JE-JOU). Cet ouvrage eut un très grand succès et fut souvent réédité en Chine et au Japon. La traduction de PETRUCCI a été établie sur l'édition lithographique de Changhai, 1887, mais il a pu en collationner le texte et les planches avec l'édition princeps de 1679 pour ce qui concerne les cinq premiers livres et avec la réédition de 1782 pour le reste.

Le *Kiai tseu yuan* est divisé en onze livres, comme suit : I. Introduction générale (j'en ai parlé plus haut). — II. Les arbres. — III. Les pierres. — IV. Les Jen-wou (les hommes et les choses tels qu'ils apparaissent dans le paysage). — V. Exemples de peintures de paysage. — VI. La peinture des iris et des orchis. — VII. Les bambous. — VIII. La peinture de prunier. — IX. Les chrysanthèmes. — X. Plantes herbacées (sans le bambou) et insectes. — XI. Plantes ligneuses et oiseaux.

Dans chacun des chapitres II à XI, l'auteur fait une analyse pénétrante de la structure des objects considérés du point de vue pictural. Il montre ensuite comment chacun des grands peintres chinois a représenté les détails de cette structure ou de quelle manière il en a fait la synthèse. Comme le remarque PETRUCCI, ces études très précises et accompagnées de croquis nombreux, seront fort utiles aux amateurs qui voudront identifier les vieux tableaux chinois en suivant les méthodes morelliennes. Mais hélas, elles ont été beaucoup plus utiles encore aux faussaires à qui elles ont expliqué en détail la manière de

(1) Ces deux éditions contiennent des planches en couleur d'une grande beauté.

ressusciter les vieux maîtres! Considérons, par exemple, la peinture de prunier. Les explications données par le peintre SONG T'ANG TCHENG-TCHONG (appellation CHOU-YA) sont particulièrement remarquables (p. 292): «l'étude de la forme est tellement précise qu'elle nous livre ici une anatomie de la fleur avec chacune de ses parties dénommées. Si le terme chinois *ting* qui correspond au calice, s'étend au pédoncule et ne comprend pas les sépales, il n'en est pas moins vrai qu'à chacun des termes chinois, nous pouvons faire correspondre un terme précis de notre botanique et cela suffit à montrer la précision et la clairvoyance d'une recherche instaurée dans un but purement esthétique». — Mais comme je le remarquais plus haut, ces analyses pénétrantes sont généralement suivies de considérations métaphysiques abstruses basées sur la comparaison de chacun des organes de la plante avec divers éléments cosmiques (le chapitre VI du livre du prunier est un cas extrême).

R. PETRUCCI a accompagné la traduction de notes nombreuses et d'un commentaire érudit et perspicace. De plus il y a ajouté deux index qui sont de vrais dictionnaires: un vocabulaire des termes techniques (p. 447-462); un dictionnaire biographique des peintres et personnages cités dans le texte ou les notes (p. 463-509). On remarquera qu'en dehors de l'introduction qui a une portée tout à fait générale, l'ouvrage est dévoué uniquement à la peinture de paysage. Mais l'intention de CHEN SIN-YEOU n'était point de s'en tenir là. Dans la préface de l'édition de 1701, il annonçait la publication d'une dernière partie consacrée à la peinture de figure. Toutefois, ce ne fut que plus d'un siècle plus tard, en 1818, que cette dernière partie fut publiée. Le texte en était dû au peintre TING KAO. PETRUCCI se proposait de traduire cette dernière partie et d'en faire le centre d'une nouvelle publication qui aurait été le complément de la première. Hélas! ce beau projet comme tant d'autres fut anéanti par la mort et sans doute de longues années se passeront avant que les qualités scientifiques et artistiques indispensables soient de nouveau réunies dans une autre âme.

En résumé, la *Kiai tseu yuan houa tchouan* intéressera beaucoup les historiens de la pensée chinoise; aux historiens de l'art chinois elle est absolument indispensable. G. SARTON.

Mieli, Aldo. *I Prearistotelici.* I (Storia generale del pensiero scientifico dalle origini a tutto il secolo XVIII; La scienza greca), XVI + 503 p. Firenze, Libreria della Voce, 1916.

The diversity of interest and the breadth of training of ALDO MIELI are well attested by the notable contributions which he has made to the history of Chemistry, to the history of Philosophy, and to the

general history of Science. Of equal value has been the stimulus which he has given in Italy to the history of science, so that a whole series of publications by other writers can be directly traced to his enthusiasm.

The present volume is dedicated to GEORGE SARTON « per l'eroica sua patria, per il suo esilio doloroso, riaffermando su queste pagine di studi sereni la condanna dell'antica rinnovata follia : La Guerra. »

It is the first of a series devoted to the history of scientific thought from its origins to the end of the XVIIIth century. Whether the monumental project conceived be completed or no, the fundamental value of this contribution cannot be disputed. Even the statement of the project is a contribution of no mean value.

This study of Greek science before ARISTOTLE, as a whole, is made, fortunately, from the point of view of one acquainted with the earlier contributions made by Babylonians and Egyptians and by one who is fully conscious of the fact that science is universal in its appeal and in its development. Too often Greek science is discussed by those whose limited acquaintance with the development of science as a whole has led to a contemptuous attitude towards the contributions to early science of others than the Greeks.

The book suffers in spots somewhat from a characteristically Italian diffuseness of treatment. It is a generous fault, enjoyed by LEONARD OF PISA, 1202, in his almost too monumental *Liber Abaci*, by COSSALI 1797, in his *Origini, trasporto in Italia, primi progressi in essa, dell'Algebra*, and more recently by CAVERNI in his *Storia del Metodo sperimentale*.

This monograph treats in 503 pages the Ionic School, the Pythagorean School, and the Eleatic School and HERAKLEITOS; two further volumes are to be devoted to the pre-Aristotelian period, to EMPEDOKLES, ANAXAGORAS, the medical scientists and the atomists, and to the formation of the ancient Greek mathematics and astronomy, the Sophists and PLATO, respectively.

The work is a study of scientific ideas, largely free from the biographical details with which many writers divert themselves from the history of science. Here and there one may dispute the assertions of the author. Thus the absolute rejection of the accounts of PYTHAGORAS by PORPHYRY and IAMBLICHUS is of late somewhat modified. To assert (p. 5) that Egyptian influence upon Greece began only after PSAMMETIK (c. 656 B. C.) is questionable, particularly in view of the recent Cretan discoveries.

The systematic consideration of the geographical, biological, psychological, astronomical, and mathematical developments among the early Greeks, with the proper background of philosophy, constitutes

the most noteworthy advance of MIELI's work over any other study of Greek science which has yet been attempted. Whether it will be possible for one individual to continue such comprehensive studies of scientific ideas to the end of the eighteenth century with anything approaching the thoroughness and scholarship of this volume is highly problematical. The mass of literary material becomes too enormous to be encompassed within an ordinary lifetime.

The bibliography, making no pretence of completeness, nevertheless presents, in brief characterizations of a large number of works, material which is of great value to any student of Greek thought and achievement in relation to the general history of science.

The further volumes of this undertaking, two of which are said to be nearly ready for the press, are anticipated with the expectation that they also will mark, as this volume does, definite advancement in the serious study of the intellectual history of man.

(*University of Michigan.*) LOUIS C. KARPINSKI.

Arabian Medicine, being the FITZPATRICK Lectures delivered at the College of Physicians in November 1919 and November 1920, by EDWARD G. BROWNE, M. B., F. R. C. P., Sir THOMAS ADAMS'S professor of Arabic in the University of Cambridge, VIII + 138 p., Cambridge, at the University Press, 1921.

In this most interesting and valuable book almost the only thing to which serious exception can be taken is the title. That can only help to perpetuate the unhappy delusion, far too common in our encyclopedias and books of reference, that the Mohammedan civilization was racially and geographically Arabian; while it may be asserted most absolutely that there never existed any such things, in a scientific sense, as an Arabian philosophy, an Arabian art, an Arabian science or, as in this case, an Arabian medicine. These sprang up in the Mohammedan civilization, but were the contributions of other races and countries and were connected with Arabia only by being written in a form of the Arabic language. They were no more Arabian than the works, though written in Latin, of a ninth century Irish monk in Ireland were Roman. It is true that Professor BROWNE knows this and explains it most carefully in the opening pages of his book. But the mischief of popular miscomprehension has already been done; and the title of a book goes much farther than the book itself.

A complete history of Moslem medicine is, of course, impossible in these 126 pages of text. We have only a sketch; but such headings as « evolution of scientific terminology in Arabic », « psychothera-

peusis », « School of Toledo », « dissection in Moslem lands », « Moslem hospitals », « fees of physicians », « dropsy cured by a diet of locusts », « early tradition of anæsthesia », will show how high is its interest. Prof. BROWNE rightly believes in anecdotes and has accumulated a number of striking « clinical cases » from Arabic and Persian records. Even the *Arabian Nights* in the Tale of TAWADDUD is drawn in. Of the physicians whose lives and methods are described AVICENNA we all know, but RAZI, a far greater name, will probably be new to non-orientalists, in spite of the several European editions of his masterly study of small-pox and measles. When, in next year's FITZPATRICK lectures, Prof. BROWNE treats in detail, as he promises, the « Qānūn » of AVICENNA it might be well, for the general *mise en scène* of his subject, to deal specifically with two matters: the relation of the physician to the physicist and the relation of both to the magician. For these AVICENNA, who had in him a dash of the systematizer and also of the charlatan, is an excellent starting point. Professor BROWNE, of course, knows the popular romances in Turkish and Arabic — probably, too, in Persian — of the life of AVICENNA, the magician. If he will compare these with the medieval European lives of VIRGILIUS the magician, he will notice how closely they agree in incidents and that there can be little or no doubt of a close relationship. Other sides of Mohammedan medicine which invite further study are hypnotism, evidently referred to as *ilm at-tawahhum* in the « Fihrist » (p. 309, l. 12, p. 312, l. 25) and the *kutub al-bāh*, the Moslem equivalent for our « self and sex » books. It would be highly interesting to know how professed physicians formally dealt with such subjects. To the first Prof. BROWNE makes general reference as « psychotherapeusis » (p. 82 ff.) and « suggestion » (p. 90); but there was evidently a specific and at least semi-scientific literature, derived allegedly from India. Does hypnotism, it may be worth while to ask, appear in Greek medicine? There are some little details which might be considered in a future edition. IBN KHALDŪN (p. 7) was almost certainly a Berber, not an Arab; to call the body of traditions of the sayings and doings of MOHAMMED « carefully authenticated » (p. 12) suggests at least that they are trustworthy — of course they are not; it is a grave misunderstanding of the development of Moslem thought to describe the Mu'tazila school of theology as « more liberal » (p. 5), although HORTEN uses the term regularly; see, to the contrary, GOLDZIHER's « *Vorlesungen* », p. 117; read ABU' I-HASAN (p. 31 foot), in spite of PAYNE and BURTON, and IBN BATTŪTA (p. 101).

There is an admirable 12 page index.

D. B. MACDONALD.

Hovelaque, Émile. — *Les peuples d'Extrême-Orient. — Le Japon.* (Bibliothèque de philosophie scientifique), 344 p. Paris, Flammarion, 1921. [fr. 7.50.]

Ce livre qui fait suite au livre sur la Chine dû au même auteur, est comme ce dernier une sorte de petite encyclopédie, — fort claire, pénétrante, sympathique, et qui n'a qu'un défaut, notamment celui d'être trop condensée. La thèse fondamentale de l'auteur c'est que l'idéal japonais n'est point, comme celui d'autres peuples, un idéal religieux ou moral, mais plutôt un idéal esthétique. M. Hovelaque est évidemment fort bien documenté, et il a cette faculté rare, surtout en France, de voir les peuples étrangers non de son point de vue à lui, mais de leur point de vue à eux. Il est clair que sans cette faculté il ne peut y avoir de vraie compréhension ni de vraie sympathie. Le livre VI consacré au Japon moderne, m'a spécialement intéressé, parce qu'il était pour moi le plus neuf. L'on ne peut s'empêcher de frémir en songeant à la tragédie terrible qui se déroule en ce moment dans ces îles privilégiées : comment la vieille âme japonaise parviendra-t-elle à se garantir contre les progrès sinistres de l'industrialisme et du matérialisme que lui impose la défense même de son existence?

Les jugements de M. Hovelaque sont généralement clairs et profonds, mais on ne peut que regretter que son éducation exclusivement littéraire ne lui permette point de voir les questions de race sous leur vrai jour. Ces questions sont essentiellement d'ordre biologique. Ce qui fait la force de la culture japonaise, c'est l'extrême pureté de sa race. Cette pureté est aussi la source de son style. De même c'est enfantin de parler de l'impérialisme allemand comme d'une création artificielle : l'impérialisme allemand tout comme l'impérialisme japonais était essentiellement un résultat, non pas une cause. L'impérialisme des peuples est comme l'ambition des hommes, une conséquence naturelle de leur vigueur. Cet impérialisme ou cette ambition collective est tout à fait comparable à une pression hydrostatique ou un potentiel. Il existe une tension vers l'équilibre qui augmente avec la différence de potentiel ; si l'équilibre ne peut se rétablir normalement et si la différence de potentiel s'aggrave, une décharge violente devient inévitable. Dans le cas des peuples, cette décharge n'est autre que la guerre.

J'aime beaucoup l'esprit du livre de M. Hovelaque. Je pense comme lui que la connaissance du Japon, comme celle de la Chine, enrichit notre âme. Elle nous enrichit par le sentiment des différences qui nous séparent, et plus encore par la découverte des trésors qui nous sont communs. Mais M. Hovelaque n'a pas aperçu la difficulté essentielle du problème, due à la contradiction suivante : tandis que l'étude

de l'idéal asiatique est extrêmement désirable — et cela implique des rapports plus nombreux et plus intimes entre eux et nous, — il n'en est pas moins vrai que le mélange des races serait absolument funeste. De cette opposition fondamentale résulteront tôt ou tard des différences de potentiel formidables et probablement des calamités qu'il est impossible de s'imaginer. Ce problème m'angoisse plus que je ne puis le dire, et je m'étonne que l'auteur ne l'ait pas même effleuré.

Sous cette réserve, ce petit livre est excellent, et il aurait suffi d'y ajouter un index pour justifier l'assertion des éditeurs, qu'il constitue un manuel complet du Japon ancien et moderne.

GEORGE SARTON.

Mediæval contributions to modern civilisation. A series of lectures delivered at King's College, University of London. Edited by F. J. C. HEARNSHAW, M. A., LL.D. with a preface by ERNEST BARKER, M. A., 268 p. London, HARRAP, 1921. [10*s*. 6*d*.]

The foregoing title, doubtless devised to attract the narrow glance and to flatter the self-sufficiency of the average present-day reader, had the effect rather of prejudicing the reviewer against the work, for how can anyone do justice to medieval civilisation who enumerates only those features which have contributed to modern civilisation? This initial prejudice was aggravated by an advertisement on the wrapper that « The standpoint of this book is the present day », and more to the same effect, and by an approving quotation on the first page of Prof. HEARNSHAW's introductory chapter of what, let us hope, is the silliest thing that Lord MORLEY ever said, namely, « I do not in the least want to know what happened in the past, except as it enables me to see my way more clearly through that which is happening today ». (1) Are we to delete from knowledge's *ample page* everything which is not concerned with the happenings of the moment? That attitude has cost us many a precious manuscript and stained glass window and would in the end leave us nothing whatever. We must know everything possible of the past, for it may enable us to cope the better with what will happen, not today only, but tomorrow and next day and the day after *ad infinita saecula saeculorum, Amen*.

Fortunately most of the authors of the ten lectures on the middle ages and their religion, philosophy, science, art, poetry, education, society, economics, and politics, have refused to be fettered by the

1 It is essentially the same attitude as that quoted at page 130 of our text from St. AMBROSE, « To discuss the nature and position of the earth does not help us in our hope of life to come ».

limitations of the title and have been free to point out gaps and sores where modern civilisation might with profit borrow balm and ballast from medieval. At the same time they frequently guard against the danger of idealising the middle ages, and the book as a whole is characterized by sound English common sense, many acute observations, and frequent flashes of wit and humor. There is not much new matter in most of these lectures, but something rather fine informs them all, and the sympathetic presentation of medieval thought and ways is accompanied by brave hopes for a better social structure and economy of our own and a somewhat surprising faith in the possibility of common action and democratic culture.

Indeed, the chief general criticism which I have to make turns out to be — rather inconsistently — that the authors have not kept as close to their title as they might. They have largely dwelt upon mental attitudes which moderns have taken or might take over from the middle ages, or which have been remote but not to be forgotten starting points of modern development, and upon « spiritual » things such as hymns and universities. But our modern civilisation is notoriously materialistic and motor. « Let's go » is its favorite slogan. Why not date this spirit back to barbarian invaders and Norse vikings, or to pilgrims and crusaders? Why is there no lecture on medieval geographical expansion and progress in navigation? Why are not the concrete things invented in the medieval period mentioned? For instance, why are not the material comforts of the modern home connected with medieval chimneys and plumbing and glass windows? Or the trench hats and artillery of the recent war with feudal armor and the invention of gunpowder?

Gunpowder is mentioned in that chapter of the book which is of closest interest to the readers of *Isis*, namely, Dr. CHARLES SINGER's sketch of science through the middle ages. This tends to correct an earlier assertion (at p. 39) that « No idea of any order in nature, or any conception of the sequence of cause and effect, awoke a scientific scepticism in the medieval mind », but Dr. SINGER might have made more of alchemy and of the experimental tendency during the middle ages as a contribution to modern science than he does. In the main, however, considering its necessary brevity, his outline seems as comprehensive and well proportioned as could be expected, and he does well to emphasize the dominance of the astrological hypothesis in medieval science. In the main, too, his account keeps abreast of the most recent investigation in the field and contains more new matter than most of the chapters; indeed, he perhaps dates or locates some medieval scientists a little too definitely. His suggestion as fairly clear-cut dividing dates between ancient and medieval and medieval

and modern science of the deaths of PTOLEMY and GALEN and the year 1543, when appeared the fundamental works of VESALIUS and COPERNICUS, is noteworthy, if not entirely convincing. So is his observation, « I seriously doubt if the title *science* should be applied to any knowledge as such, but should not rather be reserved for the *process which makes knowledge.* »

In general Dr. SINGER's sketch is so dependable that one or two slips or questionable statements should be pointed out. It is unlikely that « The student of an earlier time » (than the XIIth century) « could find no effective Christian teacher of literary Arabic » (p. 125), since a IXth century ecclesiast was shocked by the way in which Spanish Christians studied Arabic and neglected Latin literature. The usual complete Latin translation of the pseudo-Aristotelian *Secret of Secrets* was by PHILIP OF TRIPOLI; JOHN OF SPAIN (p. 127) seems to have translated only the medical portion. The quotation from AMBROSE (p. 130-131) is scarcely a fair sample of the total attitude toward natural science of the *Hexaemeron* of BASIL from which AMBROSE copied the statement in question. BARTHOLOMEW (p. 139) should be ANGLICUS, not DE GLANVIL who lived centuries later, and the fixed date in the career of BARTHOLOMEW of England is 1230, not 1260. WITELO (p. 140-141) is scarcely « the earliest » of the group of scientists mentioned, and he should be dated c. 1270 rather than c. 1250, since his *Perspectiva* is dedicated to WILLIAM OF MOERBEKE, penitentiary to Pope CLEMENT IV, later archbishop of Corinth, and whose translations date from 1268 to 1281 or later. At p. 112 Dr. SINGER, and again at p. 149 Rev. PERCY DEARMER continue to associate the date 1453 with the spread of Greek letters to the west, regardless of the warning sounded by Professor HEARNSHAW at p. 37.

None the less, it is Rev. PERCY DEARMER's lecture on Art that has especially filled me with joy and gladness, and I wish that every modern might read it. And every reader should have his own copy, because he will probably be irresistibly stirred, as I was, to underline passage after passage — for instance, « if PERICLES had worn a top-hat and spats, where would PHEIDIAS have been? » — and even if he has no scruples against defacing the copy belonging to a library or to a friend, he will probably find that in any alien copy someone else has already done the underlining.

LYNN THORNDIKE.

(*Cleveland, O.*)

Sir T. Clifford Allbutt. Greek medicine in Rome. The Fitzpatrick Lectures on the History of Medicine delivered at the Royal College of Physicians of London in 1909-1910 with other historical essays, in 8vo., xiv+580+53 p. Macmillan & Co , London, 1921.

The Fitzpatrick lectures proper occupy 388 pages of this notable volume; supplement this number with the congruous matter contained in the author's essays on Byzantine Medicine, Public Health service and Salerno (in which the fading traditions of Greek and neo-Latin medicine are linked up with the Middle Ages) and we have a total of 474 pages bearing upon the propagation and development of Greek medicine in Rome. Breadth and subtility of scholarship is impressed on every page of this new contribution from the Regius of Physic at Cambridge. As style is habitual with a man, we need not dwell on the sustained charm and allusive grace of presentation. There is a dynamic prepotency in his faculty for compressed statement that places him apart — apart from other medical historians — in a kind of perpetual felicity. Sir Clifford has that skill in phrasing that often involves one in perilous departures from the usages of speech to which average mankind is very properly restricted; and he holds this gift without any countervailing rhetorical flaw. Flawless too, is the manner in which his historic background is laid in, — the racial and cultural elements of primitive Rome. Rome is the vast dark background against which he projects the processions and conflicts of human ideas as they gathered from east to west. The predilection of the author for « denationalized origins » of medical theory, « the pure form and growth of medical thought » irrespective of nations and tongues, is early manifested and gives rise to rich and varied reconstructions. He holds himself free to make large digressions in space and time, so as to link up the chains of thought from generation to generation. This is what Billings describes as obtaining a « parallax in time ». The only untoward result of this is an agonizing giddiness, a labyrinthine vertigo, which soon passes away.

Rational procedure in medicine was in no sense the creation of Rome, but came, with the settlement of Greek physicians in Rome and the Roman colonies, as « a superfetation upon, not an ingredient in, the national character ». Rome was but the arena whereon Greek met Greek in a furious and fateful conflict of ideas. And shrewd brushes they were, by the Rood! With what clamor, gusts of passion, shifts of fortune, this conflict went on, we may read in Galen. But to understand just why the rising medical sects at Rome, like infinitely repellent particles, went slithering away from one another on slight differences of doctrine it is necessary to retrace « long and broken ways of history ».

Ionian elements constitute such a large part of the total content of Greek medical theory that we must survey with minutest care the physical and physiological inquiries of the Ionian nature philosophers and of the Italo-Sicilian schools. Remote in time as these considerations are, the author repeatedly warns us that without them the doctrines of the Greek physicians in Rome, of the Methodists and Pneumatics for example, cannot be comprehended. Sir CLIFFORD's rehearsal of the ancient and several philosophical syntheses, « the cosmogonies of those brilliant children, the Ionians », is eloquent but difficult; for the elder Ionians became « twice infants, rocked in the cradle of speculation » and their speech was gnomic and oracular. We have less difficulty in keeping our bearings among the Italo-Sicilian factions, but even here, the veiled, cryptic, half-symbolic guesses as to the nature of the atom and the mystery of motion tease us out of mind, elude our pains. They will not readily be drawn out in lucid categories of precision and reveal their worth to medicine. Ancient philosophical thought is of sovereign importance for later biological history — those who undo the corded bales find splendid stuff. There were dissections done in Ionia and Southern Italy, auguring good physical physiology. Ionian seers perceived the key to living processes to be a mode of combustion.

PYTHAGORAS, ALCMAEON, EMPEDOCLES, DIOGENES OF APOLLONIA form a Cyclopean group between whom and ourselves Sir CLIFFORD removes the awful distance. Entertaining their theories however carries the peril that comes from conjuring spirits; PYTHAGORAS redivivus will visit some mischief upon any author who does not give him instant employment, for he is known of old to have committed weird rogueries.

Passing to the chief medical protagonists in Rome, it must now be clear that time can neither dissipate the « heat at the centre », nor abate the volume of vital energy, in such men as ASCLEPIADES, THEMISON, CELSUS, SORANUS, ARCHIGENES, RUFUS and GALEN. Here were genuine colossi, dominating, achieving, through resistless intelligence. These figures are drawn in full length-drawn with the pencil of INGRES, be it added. The imperishable meaning of their work, the social significance of their lives, break down all the reticences which the ages would interpose. An intensely vivid human drama was that which enframed the adventurous Greek practitioners in Rome. Mark also, by the controversies raging along such bitter courses, that this will be accounted one of the greatest burgeoning periods in the history of the human mind. The degree of insight, the amount of scholarship, seasoned but unincrusted, which Sir CLIFFORD brings into play in the imperial period is nothing short of amazing. He styles himself a child in scholarship — what then, is a grown man in

England? His thrice-expressed fear that he has « failed to bring the Greek physicians in Rome out of chronological tables and to present them in living portraiture », awakes no echo in the charmed mind of the reader. In summarizing he says : « I have made a fair endeavour to illustrate the inner movements, and to read the genius, of those variously gifted races of whom Roman medicine was engendered — the dreamy Sicilian, the positive and sagacious Greek, the subtle and demonic Oriental — which, blended in Sicily and Alexandria, inspired the motley players who walked the stage of our art and mystery at the feet of the imperious mistress of the world ».

We are very grateful to the author for the inclusion in this volume, of his essays on « The rise of the experimental method at Oxford », « Medicine in 1800 », « Medicine in the xxth Century », and his delightful paper, reprinted from the Proceedings of the British Academy, on « Palissy, Bacon, and the Revival of Natural Science »

(*Boston.*) EDW. C. STREETER.

Ludwig Choulant (Dresden, 1791-1861). *History and bibliography of anatomic illustration in its relation to anatomic science and the graphic arts.* Translated and edited with notes and a biography by MORTIMER FRANK (1874-1919). XXVII + 435 p. The University of Chicago Press, Chicago, 1920. [10 Dol.]

CHOULANT's *Geschichte und Bibliographie der anatomischen Abbildung* (Leipzig 1852) has long been a classic, and if the readers of *Isis* were exclusively historians of medicine it would be superfluous to underline its importance As many readers, however, are not physicians, nor anatomists, it is well to say a few words of the original work before introducing to them this excellent translation. CHOULANT was a very industrious Dresden physician, who found time to publish many important historical works, chiefly his *Handbuch der Bücherkunde für die ältere Medizin*, 1828 (new ed., 1842; anastatic reproduction 1911) and the *Geschichte* now under consideration. Both works are learned and carefully made compilations, the value of which is certainly great; but to call their diligent author a « great man », even to place him on the same level as LITTRÉ, DAREMBERG and HAESER, is one of these exaggerations into which biographers are but too likely to fall.

The aim of CHOULANT's *Geschichte* was to study the development of anatomic illustration from two points of view : (1) the aid rendered to anatomic science by the graphic arts; (2) the aid rendered to the graphic arts by anatomic science. The results of his long researches

were offered in the form of a series of monographs of anatomists (MONDINO, MARC ANTONIO DELLA TORRE, MAGNUS HUNDT, VESALIUS, etc., and artists (LEONARDO DA VINCI, MICHELANGELO etc.), with abundant and precise bibliographies, — the whole being preceded by a short historical introduction. The history of anatomic iconography is divided by CHOULANT into six periods: (1) prior to BERENGARIUS DA CARPI (1521; (2) from BERENGARIUS to VESALIUS (1521-1543); (3) from VESALIUS to CASSERIUS (1543-1627); (4) from CASSERIUS to ALBINUS (1627-1737); (5) from ALBINUS to SOEMMERING (1737-1770); 6) after SOEMMERING.

To come to the translation. The late Dr. MORTIMER FRANK, realizing the importance of CHOULANT's investigations, but keenly aware of the many additions which have been made to our knowledge since 1852, undertook in 1916 the compilation of a revised translation. The main additions are due to the wonderful activity of KARL SUDHOFF, and they alone would have given to FRANK's translation the value of a new book; — but as his task grew, the translator became more ambitious and gradually enriched CHOULANT's work with a large amount of complementary information inserted either in the text or in the footnotes.

Aside from the Introduction, the chapters not devoted to single individuals (these are too numerous to be quoted) are the following. Anatomic illustration of antiquity and of the middle ages; Manuscript illustration of the pre-Vesalian period (by FRANK, summarizing SUDHOFF's investigations): Drawings showing influence of tradition upon early illustration. The Provençal-Basel skeleton and other graphic skeletal representations of the middle ages. MS. diagrams of the *foetus in utero* and their origin from MSS. by SORANUS (by the way, this evolution is remarkably free from oriental influence, the tradition of obstetric drawings going back directly to antiquity without the mediation of the Arabs). Schematic drawing of the eye. Schemata of male viscera in bloodletting manikins of the XVth cent. Schemata of the female viscera *in situ* c. 1400-1543. (all this is splendidly illustrated) — Fugitive sheets with pro-Vesalian anatomy (p. 156-167) — Turkish anatomy (p. 330; apropos of an anatomy published in Scutari 1815 by the Ulema SCHANI ZADEH) — Works on artistic anatomy (p. 351-361; a list completing the bibliographic information given in previous sections).

As if this revised edition were not in itself a sufficient gift, the editors have added to it a series of appendixes: The life of JOH. LUD. CHOULANT by FRANK, including a bibliography — A memorial notice of MORTIMER FRANK by F.-H. GARRISON — Chinese anatomy by CHOULANT (from *Illustr.-med. Ztg.*, t, 3, p. 211-216, München 1853) — Sculpture and painting as modes of anatomical expression by F.-H. GARRISON and Edw. C. STREETER. — Anatomical illustration since the time of

CHOULANT by F.-H. GARRISON (a critical bibliography with brief preface).

The way in which this excellent book is got up is a credit to the University of Chicago Press.

G. S.

G. Bohn. — *Le mouvement biologique en Europe*, 144 p. (185 × 120). Paris, A. COLIN, 1921. [4 Fr.]

Chargé par le ministère de l'instruction publique, en 1913, de visiter en Autriche-Hongrie, en Russie et en Allemagne, les centres les plus actifs des recherches biologiques, G. BOHN vient de publier les réflexions suscitées en lui par son passage dans les laboratoires de Strasbourg, Heidelberg, Wurtzbourg, Munich, Vienne, Cracovie, Moscou, Saint-Pétersbourg et Berlin.

Les savants allemands, trop spécialisés, et les splendides laboratoires qu'ils dirigent, lui ont semblé, somme toute, fort peu intéressants, à l'inverse de l'impression qu'il a reçue en Pologne et en Russie, et de celle qu'il ressent en France, en présence de BATAILLON, de FR. HOUSSAY, et de... lui même. Et il pense, avec juste raison d'ailleurs, que « la production scientifique d'un peuple est étroitement liée à sa mentalité sociale ». Si la science allemande lui semble en décadence, — un des symptômes les plus nets de ce fait étant représenté par le succès des théories néo-vitalistes en Allemagne, des théories de DRIESCH — c'est qu'elle est trop spécialisée, trop organisée. « Si la discipline renforce l'esprit de logique, elle tue au contraire l'esprit d'invention ». L'idée est intéressante, mais elle est insuffisamment développée.

On trouve d'ailleurs dans ce livre trop de choses qui n'ont, à tout prendre, qu'un lien fort éloigné avec le mouvement biologique en Europe. En dehors des descriptions de certaines expériences de PRZIBRAM, KAMMERER et autres, à l'Institut de biologie expérimentale de Vienne, sur la régénération, ou l'action des divers facteurs du milieu extérieur sur l'évolution des organismes, de celles de PAVLOV et de ses élèves, dans les trois laboratoires qu'il dirige à Saint-Pétersbourg, sur les phénomènes cérébraux, de quelques autres travaux qui ne sont guère qu'indiqués, et d'un chapitre où l'auteur cherche à montrer que l'étude de l'hérédité, qui accapare actuellement le plus grand nombre des biologistes, doit céder le pas à celle de la morphogénèse, on trouve une longue description, d'après SIEDLECKI (Cracovie), du fameux jardin botanique de Buitenzorg, un chapitre (p. 35-45) sur le socialisme de KARL MARX, opposé à l'individualisme, la discussion de cette opinion de MAZARYK que « la jeunesse est conservatrice parce qu'elle n'a pas d'expérience », etc.

Au reste, il est difficile de savoir à quels lecteurs l'ouvrage est destiné; parlant d'animaux ovipares et vivipares, l'auteur croit nécessaire de définir ces qualificatifs, tandis qu'il est question ailleurs, sans explication, de la pariétale ascendante, des tropismes, de paranoïques,... termes dont le sens est cependant beaucoup moins généralement connu que celui des précédents. L. GUINET.

Ernst v. Meyer, *Professor der Chemie an der Technischen Hochschule in Dresden*. Geschichte der Chemie von den ältesten Zeiten bis zur Gegenwart, zugleich Einführung in das Studium der Chemie. Vierte Auflage. XIV + 616 S. in 8°. Leipzig, VEIT & C°, 1914

Schon die erste Auflage dieses Buches (1888) hatte eine Lücke in der deutschen wissenschaftlichen Literatur auszufüllen, denn seit dem Erscheinen von KOPPS klassischem Werke waren mehr als vierzig Jahre verflossen. Seither ist das Buch als standard work der chemischen Geschichtsschreibung stets unentbehrlicher geworden. Die vierte, im Vergleich mit der dritten wieder stark angewachsene Auflage bietet in mehreren Richtungen grosses Interesse. Es werden daraus die Fortschritte der chemisch-historischen Forschung sowie der Chemie selbst in der etwa zehnjährigen Zeit seit dem Erscheinen der dritten Auflage augenscheinlich. Die Hauptpunkte in ersterer Hinsicht seien hervorgehoben.

Ueber die Chemie der Aegypter hat der Papyrus von Leyden und jener von Stockholm wertvolle Aufschlüsse gegeben. Sie besassen erstaunliche Kenntnisse über Metalllegierungen, Edelsteinfälschungen und Farbstoffe. Hingegen hat WIEDEMANN nachgewiesen, dass die chemischen Kenntnisse der Araber früher überschätzt wurden. Die Ergebnisse BERTHELOTS auf gleichem Gebiete bedürfen nach den Arbeiten von LIPPMANNS und DIELS' einiger Einschränkungen. JOACHIM JUNGIUS wird als Vorläufer BOYLES warm gewürdigt. Desgleichen, auf Grund von Forschungen MENSCHUTKINS, der russische Forscher M. W. LOMONOSSOW (1711 bis 1765) als Vorläufer LAVOISIERS und frühzeitiger Verfechter der Atomenlehre, der kinetischen Wärmetheorie und der Energieerhaltung. Ueber die Aufstellung der Atomenlehre durch DALTON hat A. N. MELDRUM in Manchester 1910 und 1911 wertvolle neue Ergebnisse veröffentlicht. Die Kenntnis AVOGADROS und der Geschichte seiner Theorien wurde durch GUARESCHI wesentlich gefördert. Die Geschichte der organischen Chemie hat eine Bereicherung erfahren, indem ANSCHUETZ ein merkwürdiges Werk des österreichischen Physikers JOSEF LOSCHMIDT aus dem Jahre 1861 entdeckte und neu herausgab (OSTWALDS *Klassiker* Nr. 190), in welchem dieser Forscher als Vorläufer KEKULÉS in der Benzoltheorie und als früher Vertreter der graphischen Darstel-

lung chemischer Formeln erscheint. Grössere Aenderungen erfuhren ferner die Kapitel über Energetik, chemisches Gleichgewicht, über die Erfindung des Rückflusskühlers und des Wasserbades, über die Entstehung des Petroleums, über Gährungserreger und Fäulnis, über die Erfindung des Porzellans, über Photographie, Kautschuck, über Universitätslaboratorien. Eine Reihe kurzer Biographien bedeutender Männer wurden neu eingefügt.

ERNST V. MEYER ist am 11. April 1916 im Alter von 69 Jahren gestorben Seine grossen Verdienste um die Geschichte der Chemie sind um so bemerkenswerter, als er bei dem Fehlen eines chemie-geschichtlichen Lehrstuhles in Deutschland diese Tätigkeit nebenamtlich verrichten musste. Vielleicht wurde ihm der Anstoss dazu durch den Umstand gegeben, dass er als einer der letzten, treuen Anhänger H. KOLBES noch in den Achtzigerjahren die chemische Strukturtheorie ablehnte und dann doch den neuen Anschauungen Raum geben musste. Seine Publikationen zeichnen sich durch den weiten Blick des Historikers aus, so die chemischen Teile des bei TEUBNER erschienenen encyklopädischen Werkes *Die Kultur der Gegenwart*, die von ihm redigiert wurden und eine längere, geschichtliche Einleitung aus seiner Feder enthalten.

(Brünn, Mähren.) ERNST BLOCH.

Carl Graebe. *Geschichte der Organischen Chemie*. Erster Band, x + 416 S. Berlin, JULIUS SPRENGER, 1920.

Here we have an intimate and delightful account of the development of Organic Chemistry during its first one hundred years — an account written by one who has figured as the prime mover in some of the spectacular advances of this subject and in close touch with all. In his preface Dr GRAEBE tells us that an interest in the historical side of chemistry has pursued him ever since his university days and that ever it has been his desire to produce a book which should supplement the ordinary text books by supplying the human factor, the steps by which the present theories of Organic Chemistry from earliest times have advanced to the point where now we may express our conceptions in established space —, or structural — formulas. The present book is evidently the fruit of years of contemplation on chemical processes from the historical standpoint; and comes after a life so filled with the details of the lecture and laboratory that now for the first time this History of Organic Chemistry has become possible.

The book begins with the work of SCHEELE on vegetable and animal chemistry from the pharmaceutical standpoint and with the reform established by LAVOISIER (which affected organic as well as inorganic

chemistry) and continues thru the XIXth century nearly to the end, to FISCHER'S work on phenylhydrazine and the recent theory of the arrangement of atoms in space. The second volume will be left to younger hands and will continue the story from about 1890 up to the present time. This latter volume, which will appear in about two years, is now being elaborated in the hands of Professor Dr. KURT HOESCH.

In order to show how in the passage of time the subject of Organic Chemistry has been developed, the present book is divided into time-sections and each such section deals with the separate investigations of the period. In this way a general picture is developed — a kind of moving picture — of the gradually changing points of view which were fruitful in the progressive development of the subject as a theoretical and experimental science.

In each period there are given short notices of the lives of eminent chemists with abstracts or references to commemorative addresses. This gives an added human interest which will be especially acceptable to those many Americans whose early education was laid in the European universities, so that they were brought into touch with these great leaders.

The *first time-section* in three chapters deals with the period from 1770 to 1810 when organic chemists were to be found almost wholly in pharmaceutical or medical lines. We learn that in SCHEELE'S time only four organic acids had been prepared: acetic and formic by distillation and benzoic and succinic by sublimation. (Salts of oxalic and tartaric acids were known, but not the free acids.) Alcohol had been distilled and converted into ether and other products. Also, Berlin blue and potassium ferrocyanide had been prepared. But in chapter I, after a short notice of SCHEELE'S life, it is shown that an original systematic method was developed by this versatile worker, by which he was able in a short time to add eight organic acids, as well as hydrocyanic acid, to the list. He developed also a method of attack upon the esters, thus laying the foundation for our present methods of saponification and the preparation of both « base » and « acid » from these « ethereal salts ». It is to be remembered also that SCHEELE was the first to prepare that important compound glycerine.

LAVOISIER'S life follows in chapter II, together with the application of his oxygen theory of bases and radicles to organic chemistry, which brought into this previously forbidding realm a new conception of compounds and the possibility of their quantitative examination. By the oxygen theory, tho it is known more prominently thru its application to the inorganic field, investigators in organic chemistry felt themselves for the first time invited to their labor rather than repelled

from a great and seemingly unwieldy mass of the animal and plant products.

The qualitative developments, following SCHEELE, rather than the slower quantitative methods of LAVOISIER, filled the rest of this period as described in chapter III. FOURCROY and VAUQUELIN continued successfully the preparation of organic acids; and other contributions followed which were necessarily of minor importance, for attention at this time was focussed upon the great discoveries in inorganic chemistry with which we connect the names of BERTHOLLET, PROUST, KLAPROTH, DAVY, DALTON, GAY-LUSSAC and THÉNARD. We remember also that in 1810 and 1811 appeared the memorable contributions of BERZELIUS and AVOGADRO.

The *second time-period*, from 1810 to 1820, is covered by Chapters IV to VI inclusive. Here are described the first elementary organic analysis, with details of the contributions and methods of GAY-LUSSAC and THÉNARD, of BERZELIUS and then of LIEBIG; the researches on cyanogen, on the composition of alcohol and ether, on starch and sugars; CHEVREUL's well known work on fats with methods by which pure products could be obtained from natural substances. It was CHEVREUL who anticipated the artificial preparation of urea by a year or two by refusing to ascribe any function to the mythical « vital force ». At this time came the first researches on the alkaloids and on the oxidation of alcohol to aldehyde and then to acetic acid; and FARADAY's preparation of halogen substitution products and of β-naphthalene sulphonic acid.

The *third period* includes the progress of discovery from 1820 to 1840. « Important new theoretical developments were established on an experimental basis, like the recognition of isomers and the founding of the first constitutional formulas. Many new interesting compounds were discovered; and the synthesis of organic preparations started on its first development. » In this work, besides GAY-LUSSAC, BERZELIUS and MITSCHERLICH, stand out preeminently the names of DUMAS, WÖHLER and LIEBIG.

The time periods now follow the decades :

Fourth period, 1840-1850, in which the work of the great chemists, already mentioned, ended; and the work was continued by younger men — especially LAURENT and GERHARDT, HOFMANN, FRANKLAND, KOLBE and PASTEUR.

Fifth period, 1850 to 1860. This is the decade which includes the new type-theory and the new radicle-theory, the labors of WILLIAMSON, BERTHELOT and KEKULÉ, with CANIZZARO and the acceptance of the theory of AVOGADRO.

Sixth period, 1860 to 1870, including the establishment of atomic weights, graphic formulas and structural formulas.

Seventh period, 1870 to 1880. Here we have very well told the dramatic story of KEKULÉ's conception of the benzene formula (1865) and its experimental verification; the variations of this formula due to CLAUS (1867) and to LADENBURG (1869); the objections to KEKULÉ's formula of BRUHL and JULIUS THOMSEN; the centric formula of ARMSTRONG-BAEYER; and the swing of preference back and forward from 1870 to 1890 between the KEKULÉ, the prism and the centric formulas; and the lack of agreement upon either one. Finally come the wonderful stories of indigo and quinone, and the constitution of naphthalene and alizarene, with which the author's name will be ever associated.

Eighth period and last, 1880 to 1890. In this decade is included an account of triphenylmethane and the azo-dyes, of researches on perfumes and lastly the « Lagerung der atome in Raum » — the arrangement of atoms in space; so that the whole long story ends with about the year 1890.

Thus we have a fascinating account of perhaps the greatest progress made in any single department of science and that too in a century in which the advances in all departments of science crowd upon each other — a story well told by one who has an easy command of language. The text is filled with quotations and references to the original articles. Moreover the interlarding of the text with the stories of the lives of the most noteworthy contributors to the advancement of the science is a pleasing device, relieving the account of any possible leaning towards monotony. To divide an historical account absolutely into decade periods is of course impossible but the author seems to gain easily the advantage of this *aide-mémoire* by judicious contributions of foresight and review, thus locking the story into a complete whole.

As one finds readily at hand histories of the time preceding his own activity but obtains with more difficulty an accepted account, with the proper perspective, of very recent years, so the reviewer whose work began in 1890 reads with the keenest pleasure this new contribution to the History of Chemistry, as presented in volume I, by Dr. GRAEBE, yet looks forward with an interest touched perhaps with some anxiety, to the appearance of the more difficult summary of the thirty recent years, as promised from the pen of Dr. HOESCH.

In so excellent a book, which is supposed to cover the world-advances in organic chemistry, it would seem proper to inquire if there were no noteworthy contributions in America until after 1890. No mention is made of REMSEN and his collaborators, of the work on the sulphonic acids and the discovery of saccharine, the founding of the *American Chemical Journal* or of the rather extensive work on American petroleums.

Germany may well be proud of her record in organic chemistry. This science begun by SCHEELE and BERZELIUS in Sweden, clarified by the theory of LAVOISIER in France, owes nearly all its development to the labors and clear insight of the German. The aniline dye industry, starting in England, found its almost complete development in the German laboratories. Possibly, nine tenths of the history of organic chemistry is frankly German. Remembering this, it seems eminently proper and fitting that we should look to that country for a sympathetic and inspiring history of this science, such as has now come to hand as a monument to that CARL GRAEBE of Frankfort who, among other discoveries, established the constitution of anthracene and gave us what afterward developed into the quinoid color-theory.

(*Amherst College.*) ARTHUR JOHN HOPKINS.

Markham, Sir Clements R. (1830-1916). *The Lands of Silence.* A history of Arctic and Antarctic exploration, XII + 539 p., with many maps and illustrations. Cambridge, University Press, 1921.

This posthumous volume edited by the care of F. H. H. GUILLEMARD is the worthy termination of an admirable career (for which see, for example, the Encyclop. Brit., 11th ed.). Many of Sir CLEMENTS' numerous publications are of interest to the historian of science; one of them, his translation of GARCIA DA ORTA'S *Colloquies* was reviewed in *Isis* by Mrs. A. Arber (t. II, 415). He was very well prepared to write a history of polar exploration, not only by his lifelong studies in the history of geography, but even more because he himself was a member of the first FRANKLIN search expedition in 1850-1851 and because, as president of the Royal geographical society, he was the chief organizer of the national Antarctic expedition under Captain ROBERT SCOTT in 1901-1904.

To appreciate fairly this history, it is necessary to bear in mind that the author's aim was *not* to write a history of scientific exploration or of the progress of polar knowledge, but rather a history of these expeditions from the seaman's point of view. In other words, he is more interested in the heroic aspect of polar discovery than in its scientific implications. If we admit that, it is not altogether fair, as has been done by another reviewer (1), to reproach the author for having given so little importance to scientific research. We must state, of course, that his history is not complete, but what Sir CLEMENTS proposed to do, he did very well. He explains his point of view on p. 174, when,

(1) HUGH ROBERT MILL, in *Nature*, vol. 107, p. 291; a careful review.

after having mentioned the presence of NELSON as a midshipman on board the *Carcass* (PHIPP's expedition of 1773 to the Greenland sea, reaching the latitude of 80° 50'N.), he remarks: « The future hero thus gained his first naval experience in the Arctic regions, as other naval heroes of lesser fame have done before and since his time... It is this phase of exploration that has the highest importance. Great as are the commercial advantages derived from Arctic discovery, and still greater as are its scientific results, the most important of all are its uses as a nursery for our seamen, as a school for our future NELSONS, and as affording the best opportunities for distinction to young naval officers in time of peace ». Sir CLEMENTS' account is very methodical, accurate and its simplicity does not detract anything from the grandeur of the deeds recorded, on the contrary.

The book is divided into two main parts: Part I, by far the longest (386 p.), dealing with the Arctic regions; part II, with the Antarctic regions. The second part is much shorter because the second history began much later. While the first expedition to the North dates back to 1553 (WILLOUGHBY and CHANCELLOR), the first expedition to the South did not occur until more than two centuries later, in 1772-1775 (COOK): the Antarctic circle was crossed for the first time in the history of civilized man by Captain COOK on the 17th of January 1773, in 39° 35' E. The scientific aspect is not entirely neglected, for each part begins with introductory chapters explaining the problems that were to be solved and ends by a conclusion setting forth those the solution of which has not yet been attained. There is also a short chapter (p. 426-429) devoted to Antarctic oceanography. Still the scientific history of polar expedition remains to be written; Sir CLEMENTS' narrative provides the human background of it, — a background in this case of heroic proportion.

I should mention that Sir CLEMENTS' book contains (p. 57) a list of astrolabes treasured in English collections. He gives a sympathetic account of HAKLUYT, remarking incidentally (p. 110) that his first book, the *Divers Voyages touching the Discoveries of America*, 1582, was the first impetus to colonization. « Virtually, RALEIGH and HAKLUYT were the founders of those colonies which eventually formed the United States ». SCOTT's two expeditions are very soberly but very effectively described and one can but subscribe to his final judgment (p. 504): « In the whole range of polar history there is no greater name than that of ROBERT FALCON SCOTT. A life of devotion to duty, latterly of devotion to scientific discovery, was closed by a heroic and glorious death. A man with rare gifts both of head and heart; those gifts were nobly used through life, and were never more prominent than in his last fatal march and in the hour of death » — But indeed the

whole history of polar expedition is an unparalleled tale of endurance and heroism.

The book is completed by a bibliography and a chronology of polar voyages. The illustrations are numerous but we would have welcomed more portraits of the great explorers.

G. SARTON.

William A. Mason. *A History of the Art of Writing.* 502 p. New York, MACMILLAN, 1920.

Mr. MASON in undertaking a comprehensive work in a field thronged with experts has shown a courage not inferior to that of H. G. WELLS. It is much more than a history of the alphabet. It attempts to trace the evolution, from primitive picture writing, of our present-day phonetic characters. The effort is certain to be severely and copiously criticized, but, on the whole, the volume — generously illustrated — is a readable and illuminating work, of which the author and the publisher have a right to be proud.

The contents bear witness to years of investigation and collection of data carried on with the enthusiasm of a real amateur. This zeal for the subject is supplemented by an exceptionally fine appreciation of artistic writing and printing. The author employs a simple and straightforward style, as free as his subject will admit from technical expressions. He is never dull, and appears to greatest advantage in the direct exposition of the facts gathered by his comprehensive studies. The generalizations are limited in number and marked by sobriety of judgment. The author has availed himself of the results of recent archeological research, and is careful to recognize that there are gaps in the story of our alphabet that are still to be made good. He supports the traditional view that the Greeks obtained their alphabet from the Phoenicians. Did the Phoenicians in turn derive their phonetic signs from the Cretans? That and many similar questions must, for their answer, await the results of further investigation.

In the opening chapter Mr. MASON shows the persistence in our present language of primitive elements, which, like rudimentary organs, afford a clue to the evolutionary process. Has development been arrested by the establishment of conventional standards? The story of progress told in this fascinating History of the Art of Writing should encourage the efforts of those who would press on to a phonetic system of writing and printing ideally economic and artistic.

It is one of the admirable features of the book that considerable space is given to the Peruvian knot-records, the picture writings of

the ancient Mexicans, those of the northern American Indians — on stone, wood, birchbark, hides, and other materials — as well as to the hieroglyphic writing of the South Sea Islanders. Subsequent chapters deal with the Chinese, the ancient Egyptians, the Babylonians and Assyrians, Hittites, Greeks, and Romans. The author exposes himself more than once to the censure of the student of hieroglyphic and cuneiform writing. Having undertaken to treat so wide a range of material he has been tempted to rely on the authority of certain scholars, whose work has at times been called in question. He follows, for example, a discredited system of chronology in the case both of Egypt and Babylonia. He seems even to confuse CYRUS with DARIUS (p. 226). Indeed, the book is in need of careful revision. It is too good in its general conception, in its spirit, and in its wealth of illustrations to go unrevised. The last three chapters deal with writing in the middle ages, European alphabets derived from the Greek, and the age of printing. The last chapter does not give a very lucid account of the invention and early history of printing. It is followed by a bibliography of seven pages.

WALTER LIBBY.

Th. Meyer Steineg und Karl Sudhoff. *Geschichte der Medizin im Ueberblick mit Abbildungen*, 444 S., 208 Abb. Jena, FISCHER, 1921.

This outline will prove highly interesting, not simply to the student and the educated physician for whom it was composed, but also to the experienced historian of medicine. For when two old masters like SUDHOFF and MEYER-STEINEG join hands in such an undertaking, we are extremely interested to find out the results of their selection: what did they finally decide to include and to omit? what were to their minds the essential points in the history of medicine? Such an outline should be consulted by the veteran historian for the sake of correcting, if needs be, his perspective. He will not refer to it for positive information, since the book was not made with that purpose in view. As the authors state in their preface, for the study of the concept of disease he should rather turn to ERNST SCHWALBE'S *Leitfaden*; for historical detail to PAGEL'S *Einführung* revised by SUDHOFF; for a comprehensive and philosophical treatment of the whole subject to MAX NEUBURGER'S *Geschichte;* for monographs on special topics to THEOD. PUSCHMANN'S *Handbuch*. To this list, I would like to add FIELDING H. GARRISON'S *History* which contains a very complete, if brief, summary of modern medicine.

But the main interest of this outline lies in the abundant and well-chosen illustrations, most of which are based upon the original mate-

rial collected by SUDHOFF in his Institute at the University of Leipzig, and by MEYER-STEINEG in his Museum at the University of Jena. The greatest part of these illustrations have already been published, chiefly by the authors themselves, but it is pleasant and stimulating to see them again following one another in orderly sequence.

The book is divided into three parts, SUDHOFF being responsible for the middle one and MEYER-STEINEG for the two others: Part I. Primitive medicine. Medicine of the ancient east and of classical antiquity down to GALEN — Part II. The middle period from GALEN's death to BACON — Part III. Modern times from HARVEY down to our days. These three parts cover respectively 140, 159 and 125 pages, with 75, 83 and 50 illustrations; that is, they are almost equal, somewhat greater importance being given to the middle one, and a somewhat smaller to the last one. This subdivision pleases me much, but it is, of course, open to criticism; that is partly a matter of taste. The illustrations relative to recent times are but few, but the student will find many more, if he wish, in GARRISON's book above-mentioned.

The student of this subject could find no better introduction to it than SUDHOFF and MEYER-STEINEG's book.

GEORGE SARTON.

Hübotter, Franz. *3000 Jahre Medizin.* Ein geschichtlicher Grundriss, umfassend die Zeit von HOMER bis zur Gegenwart unter besonderer Berücksichtigung der Zusammenhänge zwischen Medizin und Philosophie, 535 p. in-f°, illustr. Berlin, OSCAR ROTHACKER, 1920 (150 autographic copies).

The author delivered a course of lectures on the history of medicine at the University of Berlin in 1915 and the book under review is an outgrowth of these lectures. Dr. HÜBOTTER's purpose is to give a readable account of the development of medicine from the heroic ages of Greece to our day. The development of the last century is of course simply sketched. A history of the special branches of medicine will appear later in the encyclopedic collection *Die Kultur der Gegenwart.* The treatment of Oriental medicine (except Islamic medicine) has been deliberately avoided because the author plans to come back to it after a long journey in Asia which he is now making and which will keep him busy for many years (when I last heard from Dr. HÜBOTTER, he was in Japan). He declares that it is impossible to give a satisfactory account of Asiatic medicine before extensive investigations have been completed. This statement has the more weight in that Dr. HÜBOTTER knows perhaps more of Chinese medicine than any other man. He has already published important contributions on this his favourite sub-

ject, and the study of Chinese medicine will probably engross the rest of his life.

To come back to the present work, Dr. HÜBOTTER has wisely concentrated the attention of his readers upon the main personalities. He has treated with special care the great medical systems of the XVIIth and XVIIIth centuries, analyzing each of them as objectively as possible. Upon the advice of one of his former teachers, Prof. F. KRAUS, he has given a particularly elaborate account of the development of the notion of irritability. Also, as is emphasized in the title, he has taken pains to show the interrelations between medicine and philosophy. It is interesting to note that according to the author the greatest heroes of medical history are: GALEN, AVICENNA, VESALIUS, PARÉ, HARVEY, HALLER, LISTER, VIRCHOW and KOCH (why is PASTEUR not included? By the way, the account of PASTEUR's work is very unsatisfactory, and CLAUDE BERNARD is not even quoted!) An excellent feature of this textbook is the inclusion of the original texts of the fundamental sources, with translations in the case of Greek fragments; what is even better, there are facsimile reproductions of many pages, for example of HARVEY's *de motu cordis et sanguinis*. The student is thus placed at once in the sacred presence of the greatest medical authors. Bibliographical information has been reduced to the essential, but Dr. HÜBOTTER refers his reader for more literature to HERMANN VIERORDT's handy *Medizin-geschichtliches Hilfsbuch* (*Isis*, III, 365).

We look forward to the results of Dr. HÜBOTTER's studies in Oriental medicine. May his investigations be successful! G. S.

Holländer, Eugen. *Die Karikatur und Satire in der Medizin.* Medikokunsthistorische Studie. Zweite Auflage, XVI + 404 S., Hoch-Quart., mit 11 farbigen Tafeln und 251 Abbildungen im Text. Stuttgart, FERDINAND ENKE, 1921.

Prof. Dr. HOLLÄNDER has been studying for many years the relations between art and medicine and collecting photographs of the works of art of medical interest. His books on these subjects have already become classical. They are: *Die Medizin in der klassischen Malerei*, 1903, second ed. 1913; *Plastik und Medizin*, 1912 and the book now under review, the first edition of which appeared in 1905. The new edition is not essentially different from the first one, though small changes and additions have been made here and there.

This study of Caricature and Satire in Medicine is subdivided as follows: Antiquity, Caricatures by Egyptians, Greeks and Romans. Satires by the Greeks (AESOPUS, ARISTOPHANES, PHILEMON, anthology); by the Romans (CATO, PLINY, MARTIALIS) and in the East (India, China,

Persia, Palestine). Middle Ages (chivalric and heroic songs, dance of death). Satire and caricature before, during and after the Reformation : JOHANN WEYER, PETRARCA, RABELAIS, ERASMUS, SEBASTIAN BRANDT, GEYLER, MURNER, MOSCHEROSCH, TILL EULENSPIEGEL, PAULIS SCHIMPF and ERNST, AGRIPPA VON NETTESHEIM, ULRICH VON HUTTEN, MONTAIGNE. XVIth and XVIIth century : MOLIÈRE, his school and German imitators — Medical fees — Satire and caricature of pathology : RABELAIS, LEONARDO DA VINCI. gout, plague, syphilis, cholera, nervous diseases etc. — Caricature of medical methods and diagnosis etc. — Quacks — Medico-political caricature and satire — Modern medical caricature.

The illustrations are excellent though not always pleasant, and are mostly of German, English or French origin. Among the coloured plates I notice some by L. BOILLY, J. GILLRAY, J. ROWLANDSON. I would personally have preferred a chronological classification of the whole material, but I quite realize that many will like better the author's scheme. G. S.

L. Lewin. *Die Gifte in der Weltgeschichte.* Toxikologische, allgemeinverständliche Untersuchungen der historischen Quellen, XVI+596 p. Berlin, SPRINGER, 1920.

This is a very elaborate study of the use of poisons from the earliest times to our own. LEWIN's investigations have been carried on in such a comprehensive and fastidious manner that his book might well be called an encyclopedia of historical toxicology. Such a subject may seem at first sight to be one of rather remote interest, but a moment of reflection will convince us to our deepest shame that it is singularly up-to-date. For poisons have been used at all times, but never on so gigantic a scale as during the latest war; and even now every « civilized » nation is keeping up a staff of chemists to discover new poisons or « improve » the old ones. The amount of poisons used during the war in the form of poisonous gases or liquids has been tremendous, and what rôle poisons will play in the next world war — if such ever breaks out — only the Devil knows.

To make a summary of such a book, which will be used as a reference book rather than read from cover to cover, is out of the question, and the best that I can do is to outline its contents.

(I) Development, diffusion and application of toxicological knowledge in ancient times : this includes such topics as the relation of poisons to magic, the use of love potions (*pocula amatoria*) and abortives, and the imaginary poisons, *ex. gr.* the alleged poisoning of wells by Jews or Christians, not to mention of course the broader subject

implied in the title, the history of toxicological knowledge in antiquity.

(II) Poisonings from the pathological viewpoint : poisonings which simulate diseases ; mental disorders caused by poisons ; stupefaction of condemned witches; diagnosis of poisoning, etc. (every topic is treated historically).

(III) Toxicological therapeutics in ancient times : antidotes; alexipharmaka; emetics.

(IV) Laws concerning poisoning : Greek, Roman, Jewish, canonic, Germanic laws. Use of poisons by the state for punishment (hemlock, p. 65-72; snake venoms; etc.).

(V) Poisonings by means of drugs : accidental and intentional poisonings by physicians; how they were dealt with in ancient times; poisonings by narcotics; accusations of Jewish physicians as poisoners ; poisonings caused by defective posology.

(VI) Poisonings caused by indirect means : *ex. gr.* by means of perfumes or of scented flowers and letters; by means of gloves, wigs or undergarments. Poisoning of wounds and of the membranes (ear, nose, rectum, vagina). Poisoned nails and weapons. Inhalation of poisons.

(VII) Suicide by poisoning : p. 121-156.

(VIII) Antiquity and signification of arsenical compounds as poisons : the first chapter tells the story down to the XIVth century.

(IX) Prominent men who were the perpetrators or victims of poisonings : Greece, Palestine, Rome (the case of ALEXANDER takes 11 pages!). — MOHAMMED; the Assassins; the time of the Crusades. — Germany from the XIIIth to the XVth cent. — France, Burgundy, Netherlands, England, Spain, Portugal, Russia during the same period. — Italy in the XIVth and XVth. — Poisonings in the XVIth cent. and later.

(X) Poisonings perpetrated by women : Down to the XVIth cent. The Renaissance in Italy and France. France under LOUIS XIV, and South Italy.

(XI) Priests who were the authors or victims of poisonings : the Emperor HEINRICH VII. — Poisonings of popes and princes of the church. — ALEXANDER VI and CÆSAR BORGIA. — Poisonings of popes in the XVIth and XVIIth cent.

(XII) Poisons in warfare : Secret introduction of poisons into the enemy's camp or country. — Poisoned arrows. — Military use of venomous animals. — Poisoned projectiles and gases.

The author's allusions to the great war are very discreet; he has not written this book with any aggressive bias or any purpose other than the purely historical one. The sources are duly given and, when suffi-

ciently brief, the relevant passages are quoted in the footnotes and translated in the text. The plan adopted by L. LEWIN has entailed frequent repetitions and not a few artificial combinations. I believe a purely chronological order would have been on the whole more satisfactory, though the author's plan has certainly some advantages. My main objection however is that the immense amount of material collected by him has not been sufficiently digested; his book gives one too much the impression of being a compilation by mere juxtaposition, rather than an organic and harmonious synthesis. At any rate it will be very useful, and for every topic, smacking however little, of poison, the historian will do well to refer to it.

GEORGE SARTON.

John Bagnell Bury. *The Idea of Progress*. An inquiry into its origin and growth, xv+377 p. London, MACMILLAN, 1920.

J. B. BURY, regius professor of modern history in the university of Cambridge, to whom we owe already, among other works, the standard edition of GIBBON and an excellent History of the Freedom of Thought, has made us a new gift, not less precious nor welcome than his previous ones. His new investigation is of fundamental importance to the historian of science, — for it is safe to assume that the latter's activity is largely impelled by his belief in progress, at the very least in scientific progress. What makes our studies so fascinating and so inspiring is the fact, which we take for granted, that science is essentially a cumulative process, and not simply a progress but an accelerated progress (1).

The idea of progress dominates modern thought to such an extent, that it takes some effort of imagination to realize its relative youth; it is not yet two hundred years old! What is the idea of progress? it means « that civilization has moved, is moving and will move in a desirable direction ». This definition evidences at once the metaphysical or adventurous character of this idea. Admitting that we can prove the reality of progress in the past and present, we can not prove its indefinite continuance in the future, nor can we prove that humanity will move forever in a desirable direction. Hence belief in progress is an act of faith, but we might as well accept at once the fact

(1) For a previous investigation on the idea of progress, a collective investigation which took place in Rome 1912, see *Isis*, II, 245. — An elaborate history was published in 1910 by JULES DELVAILLE, *Histoire de l'idée de progrès jusqu'à la fin du XVIII^e siècle*, 773 p. Paris, ALCAN. I have ventilated my own thoughts on the subject apropos of RADL, « Geschichte der biologischen Theorien », in *Isis*, II, 226-227.

that inasmuch as the future is unknown, man can not live without faith. His very activity implies some sort of faith. The assumption of progress belongs to the same order of ideas as the belief in Providence or personal immortality. Yet there is a great difference which will be sufficiently illustrated by the fact that the development of the idea of progress is intimately connected with the growth of modern science, the growth of rationalism and the struggle for political and religious liberty.

It is very curious that the Greeks, even the wisest of them, never hit on the idea of progress : their historical experience was far too small, and they were trammelled by their theories of Moira, of degeneration and cycles and their intellectual conservatism. The only ancient writer to conceive this idea, as restricted to scientific progress, was SENECA, who said, « One day our posterity will marvel at our ignorance of causes so clear to them », (1) a magnificent sentence which every scientist should always keep in mind. The spirit of the Middle Ages was not less incompatible with the birth of this idea, for their exclusive and narrow conception of Providence and their apocalyptic dreams were absolutely opposed to it. It is only with the Renaissance, when self-confidence had been restored to human reason, that the idea could germinate, though at the beginning the authority justly ascribed to the ancient writers was so overwhelming that the little seedling could grow but very slowly. It was not until COPERNICUS, VESALIUS and others had crushed this superstitious reverence that its existence was assured. The first to grasp the idea were GUILLAUME POSTEL, 1541 and JEAN BODIN, 1566. BODIN asserted the principle of the permanent and undiminishing capacities of nature; he claimed that the world had not degenerated since ancient times; he conceived all peoples as partners in one common undertaking. The next author considered by BURY is FRANCIS BACON for whom utility was the end of knowledge. But a greater step forward, — perhaps the greatest single step in the whole history of this idea, — was taken by DESCARTES. For it was only after the supremacy of reason and the invariability of the laws of nature had been proclaimed that the notion of progress could really flourish. A little later, at the close of the Cartesian period, FONTENELLE was the first to formulate the idea of scientific progress as a complete doctrine, and he contributed a great deal to its diffusion by his brillant efforts to popularize accurate knowledge. The first, however, to « express in definite terms the vista of an immensely long progressive life in front of humanity », to conceive civilization as

(1) Venit tempus, quo posteri nostri tam aperta nos nescisse mirentur, *Natur. quaest.*, VII, 25.

being only in its infancy, was the good abbé DE SAINT-PIERRE in 1737. The development of the idea of progress was now considerably activated by the work of TURGOT, who anticipated COMTE's law of the three stages, and by the Encyclopædists. The latter indeed were inspired by two conceptions which were, so to say, fragments of the idea of progress : the solidarity of the sciences (already clearly seen by ROGER BACON) and the popularization of knowledge. They believed implicitly in the « indefinite malleability of human nature by education and institutions » and consequently in its indefinite improvement.

These efforts and some others which may be found in BURY's book constitute what may be called the first period in the history of the idea of progress. This first period extends up to the French Revolution. A new period was opened (1774) by KANT, who saw the immense significance of this idea but made it clear that nothing could be affirmed about the course of civilization until the laws of its movement had been discovered. That is what COMTE tried to do. This second period is characterized by the search for a definite law of progress; incidentally, sociology was founded. A third period may be said to begin in 1859, with the publication of the *Origin of Species*, though the most effective extension of the idea of evolution to that of social progress, SPENCER's contribution, partly antedated DARWIN's discovery. However, it was the Darwinian, rather than the Spencerian theories, which established the notion of progress in its present commanding position.

No definite law of progress has yet been formulated, yet this idea dominates modern thought and inspires modern action. The tremendous compelling power of the principle of duty to posterity — a direct consequence of our belief in progress — is the best proof of this.

My summary, however brief, is, I hope, sufficient to show the importance of BURY's book. It is truly an excellent book, one of the best I have read for a long time. My only criticism of it is that the notes have been placed at the end of the volume, which is most irritating. Should this disposition be kept in later editions, I would suggest that asterisks be inserted in the text to warn the reader of the presence of a note.

G. SARTON.

Reiche, Fritz. Die Quantentheorie. Ihr Ursprung und ihre Entwicklung. VI + 231 p. Berlin, SPRINGEN, 1921.

This little book is essentially an expanded edition of the essay published by the author in the number of the journal *Die Naturwissen-*

schaften devoted to PLANCK. It is a clear and comprehensive summary of the theory of quanta. Mathematical developments have been avoided as much as possible or rejected in the notes printed at the end of the volume (p. 162-231). REICHE's book will be very useful not simply to the student of physics, but also to the historian of modern science. MAX PLANCK's theory was born in 1900 : it was one of the last great achievements of the XIXth cent. In fact, PLANCK's discovery was perhaps the greatest event of the year 1900, together with the rediscovery of MENDEL's ideas. The theory of relativity was a consequence of the MICHELSON-MORLEY experiment ; in the same way, the theory of quanta resulted from the difference between calculated and observed values of the radiation of a black body. The student of the history of physics will do well to read REICHE's book because of the light it throws retrospectively upon the development of our ideas on radiation. The theory of quanta is still full of mystery; suggestive and useful as it is, one can but feel that we have not yet reached the bottom of it, and such a feeling is extremely stimulating. GEORGE SARTON.

George Sidney Brett. A History of Psychology, vol. II, 394, p. and Vol. III, 322 p. London, GEORGE ALLEN & UNWIN, and New York, MACMILLAN, 1921.

G. S. BRETT, professor of philosophy in the University of Toronto, has now completed his work on the history of psychology, the first volume of which appeared in 1912. This first volume dealt with the Ancient and Patristic Psychology; the second volume covers the Mediæval & Early Modern Period, and the third treats of Modern Psychology. This is the best work that has yet appeared in this field; it will soon be recognized and long be remembered as a classic among books concerning the history of the sciences. It should be read by every student of philosophy and psychology. The writer of this review can bear witness to the value of these three volumes for such instructors as may undertake to offer courses for graduate students in the history of psychology. Professor BRETT's mastery of-up-to-date psychology in its various departments, his knowledge of the philosophical foundations of this discipline, and the critical acumen he brings to bear on the great problems must command the respect and stimulate the interest of all advanced students of psychology.

After a careful reading of the whole work one is impelled to ask whether a knowledge of its contents might not lead our professors of psychology to reform their methods of presenting their subject to

undergraduates. Is it not possible that the history of psychology, as the history of science in general, might exert a humanizing influence on both student and instructor? Would the WEBER-FECHNER « Law » be presented in the same spirit if the criticisms that have been leveled against it were known and appreciated? Would the « JAMES-LANGE » Theory of the Emotions call forth the same attitude in instructor and student if the views of ARISTOTLE and LOTZE, and many others, in reference to the relation of emotions and physiological concomitants, could be studied along with the views of LANGE and JAMES?

« It is an open question », writes Professor BRETT, « whether a psychologist can be an idealist or a realist. He should perhaps be simply a psychologist. But apart from collectors of detail and writers of monographs, history has failed to produce a psychologist who was not a philosopher of some kind; and it is notorious that a rejection of all metaphysics is the most metaphysical of all positions. The fruits of the sciences may be plucked by every chance comer; yet the tree that bears them must strike its roots deep or quickly wither away. » Whether Professor BRETT's readers are in full sympathy with this passage or not, even those most inclined to positivism cannot deny that much of our present-day psychology is very superficial, and that its foundations — so far as it has any — will not bear the test of criticism. To our lack of well grounded principles, our inadequate knowledge of the history of psychology, other charges must be added — essential ignorance of mental disease, physiology, anatomy, and neurology. Should we attempt to « explain » the soul in terms of the autonomic system and the neurons if we have never handled a scalpel nor looked down a microscope? Moreover, should the court of the Queen of the Humanities be crowded by those who have never read SHAKESPEARE nor turned a page of MOLIÈRE?

Professor BRETT connects the history of psychology with the history of the other sciences, as well as with the history of philosophy. He shows the influence of NEWTON's discovery of the law of gravitation on the English Associationism of the eighteenth century, the results of the physiological researches of JOHANNES MÜLLER and his pupils on the nineteenth century psychology, and the influence on the mental sciences, at various periods, of natural history and biology. Professor BRETT is familiar with the history of anatomy and the medical sciences in general. His sketch, however, of anatomy in the fourteenth, fifteenth, and sixteenth centuries (page 141, vol. II) is in need of some revision. For example, no mention is made of the dissections of LEONARDO DA VINCI. The first edition of the *De Humani Corporis Fabrica* appeared before, not after, the discovery by SERVETUS of the lesser circulation of the blood.

Those interested in the history of science will welcome Professor BRETT'S recognition of CABANIS as the founder of modern physiological psychology. Does not ROUSSEAU deserve a larger place than this work gives him as the father of child-study? It is a mistake to say that WUNDT became the successor of HERBART at Leipzig (p. 152, vol. III). Among minor errors and misprints might be noted : *1660* as the date for the death of DESCARTES, instead of 1650 (p. 194, vol. II); *Réné* for René (p. 197, vol. II); *Cherburg* for Cherbury (p. 222, vol. II); *lead* for leads (p. 352, vol. II); *bei Kinder* for *bei Kindern* (p. 337, vol. II); *Rapports de physique et de morale de l'homme* instead of *Rapports du physique et du moral de l'homme* (p. 388, vol. II); *keine Gedanke* for *kein Gedanke* (p. 173, vol. III); *Russell Wallace* for *Russel Wallace* (p. 225, vol. III); *élan vitale* for *élan vital* (p. 267, vol. III); *langage intérieure* for *langage intérieur* (p. 312, vol. III). Professor BRETT speaks of BICHAT as the founder of modern anatomy, where the expression founder of general anatomy (that is, an anatomy of the tissues) is to be preferred.

WALTER LIBBY.

Lewis Spence. An Introduction to Mythology. 335 p. London, HARRAP, 1921.

« The purpose of this book is to provide the reader with a review of mythic science from its beginnings down to the latest guesses of contemporary authorities ». That is, the author is chiefly concerned with the principles of mythology, and furthermore with the development of these principles. This book is thus of direct concern to the historian of science, who might not be interested in mythology itself, — though it is impossible to understand the beginnings of science without reference to it, — but who can not help being interested in the history of mythology, in the evolution of human ideas concerning myths. Mr. LEWIS SPENCE has already written many useful books dealing with mythology, chiefly of tropical America, and what he calls an « introduction », is for him rather a conclusion.

An introductory chapter is devoted to definitions and general questions. « The function of mythology is the investigation and explanation of myths or tales relating to the early religious and scientific experiences of mankind. It throws light upon the material, methods, and progress of primitive religion and science, for many myths are an attempt to explain physical as well as religious phenomena ». After this preliminary definition, the author quotes many others to determine more exactly what mythology is and what it is not, and to differentiate it from other objects of study, such as folk-lore, legend, religion. Chapter II, to which I shall come back pre-

sently, deals with the « Progress of mythic science » (p. 40-101), and the remaining chapters treat successively the following topics : III, the evolution of the gods ; IV, the various types of deity ; V, the various classes of myth ; VI, the making of the world and of man (cosmogony) ; VII, paradise and hell ; VIII, folklore and myth ; IX, ritual and myth ; X, the written sources of myth ; XI, the great mythic systems of the world. — It is, as one sees, a brief but comprehensive encyclopaedia of comparative mythology. Its usefulness to the student is greatly enhanced by excellent comparative tables, on the various classes of myths (p. 144-157) and on the principal creation myths (193-194). Of course chapter VI on cosmogony, is of special importance for the student of early science.

Chapter II offers us a very interesting history of mythological science from Xenophanes of Colophon to our days. I think it worth while to quote rapidly the principal personalities considered by Mr. Spence : Xenophanes ; Theagenes of Rhegium : Pherecydes of Syros ; Hecataeus of Milet ; Pherecydes of Leros ; Euhemerus (IVth cent. B. C.) ; . . . . . ; Francis Bacon ; De Brosses (the first writer to strike upon the true line of interpretation, 1760) ; Lafitau (1724) ; Friedrich Schelling ; Creuzer ; K. O. Müller (the truly scientific treatment of myths begins with his *Prolegomena zu einer wissenschaftlicher Mythologie*, 1825). Then comes the « philological school » grouped around Max Müller (1823-1900), from which arose later two sub-schools, the solar headed by Müller himself (they saw sun-gods everywhere) and the meteorological, led by Kuhn and Darmesteter (they saw in all myths the phenomena of thunder and lightning). But it was not possible to explain everything in this way and the « anthropological school » developed, as more Aryan and non-Aryan myths were shown to be identical. Sir E.-B. Tylor was first to lay down the anthropological point of view with clearness and accuracy (*Researches into the early history of mankind* 1865, *Primitive culture* 1871) ; John Ferguson Mc Lennan (totemism) ; Herbert Spencer ; William Robertson Smith ; Cornelius Petrus Tiele ; Andrew Lang. The latter was the more influential exponent of the anthropological school ; he demonstrated the unsoundness of the « disease of language » theory ; laid stress upon the irrational element in myth ; indicated the complexity of mythic development ; applied the idea of evolution to mythology ; showed that the persistence of myth is caused by religious conservatism. Of our contempories, the following have attracted particularly the author's attention : Sir James George Frazer, of course ; E.-J. Payne ; Salomon Reincah ; F.-B. Jevons (reflection of myth by ritual) ; R.-R. Marett ; Sir George Laurence Gomme ; Rendel Harris, and finally George Elliot Smith whom he names « the Galileo

of mythology », a description which will not be universally approved. Prof. SMITH, it may be recalled, is the chief supporter of the pan-Egyptian theory : he finds traces of Egyptian influence everywhere, even in America. GEORGE SARTON.

Charles Singer (*editor*). Studies in the history and method of science. Volume II, XXII + 559 p., LV pl. and other illustr. Oxford, Clarendon Press, 1921 [L. 2. 8. 0].

I have reviewed the first volume of the *Studies* in *Science*, vol. 47, p. 316-319, and its contents have been analyzed in the Seventh Critical Bibliography. The new volume shows in every respect great progress upon the first ; it is considerably larger and its contents are more varied. There are in all fifteen memoirs which can be classified as follows : 7 deal with biological or medical sciences, 4 with physical sciences, 1 with mediaeval science in general, 3 with philosophical questions. Or in another way : there are 12 original memoirs ; 2 extensive reviews and 1 translation.

Each of these items will be analyzed in the bibliography, but I must speak at greater length of the first memoir by CHARLES SINGER on *Greek biology and its relation to the rise of modern biology*, not simply because of its importance, but also because of its polymorphism, — of the impossibility of classifying it anywhere. Of course it is a study of the development of biology, but to call it a study of Greek biology would be misleading for it contains a great deal of information on mediaeval subjects. As a matter of fact, its most original part is a study of mediaeval botany ! This very valuable memoir is not simply « polymorphic », but highly heterogeneous. The first chapters are devoted to a general comparison between the spirit and methods of ancient and modern science. This is very suggestive, and I am in agreement with Singer on all points, except when he tries to minimize the importance of the recovery of the original texts of the Greek scientific classics. I think that SINGER overstates his case. He is right when he says (p. 6) : « Above all, we need to distinguish mere *passive increase* of knowledge brought by the revival of the Greek language from the *active extension* of knowledge by direct observation that is the essence of the experimental method. This process of active extension began centuries before the learned Greek revival and received its great impetus long after it. » Yet the fact remains that in the XVth century the shortest road to science (as distinguished from a mere accumulation of facts) was the recovery of ancient science in its pristine purity. Greek science was the fruit of the sustained efforts of some of the greatest intellects of mankind ;

it represented the accumulated experience and wisdom of many centuries. If the results of these efforts had not been recovered, the progress of modern science would have been considerably delayed. The study of Greek was as essential in the fifteenth century as the study of one of the European languages is now to any Oriental who wishes to undertake scientific investigations. That is what men like PURBACH and REGIOMONTANUS clearly understood. It is possible that our misunderstanding on this subject is largely due to the fact that SINGER's standpoint is that of the biologist, while mine is rather that of the astronomer and mathematician. After this introduction follow two chapters (III, IV) dealing with Aristotelian biology. In the first of these SINGER examines very carefully its fundamental ideas (classification; phylogeny; ontogeny); in the second he gives us a very interesting account of « some Aristotelian zoological observations and their modern counterparts », to wit: the placental shark, the ruminant stomach, the generative processes of cephalopods, the habits of the fishing-frog, torpedo and bees. These two chapters contain nothing which is essentially new, but one must be grateful to SINGER for his very lucid exposition, and the readers who are not professional zoologists will especially appreciate the abundant illustrations. As far as I am concerned, this is the first time that I have been able to study Aristotelian zoology without continual and tiring reference to zoological textbooks. The two last chapters (V, VI) are botanical, They contain an elaborate investigation of Greek botany, and SINGER's account of THEOPHRASTUS has the same qualities of clearness and simplicity as his account of ARISTOTLE, but the chief feature of these chapters (and indeed of the whole memoir) is a study of mediaeval botany; that is essentially, a study of botanical iconography (V, b and c). The author is here at his best. He has made a rich collection of the botanical and biological pictures to be found in early manuscripts and a great deal of this material is entirely new. The memoir contains admirable reproductions (some in colour) of these early pictures. The reader can but regret, however, that these illustrations are not more intimately connected with the text (1). Sometimes one has the painful feeling that the text is telling one story, and the pictures another. At any rate it is certain that the greatest defect of this rich memoir is its heterogeneity: for it would have been much better to devote a separate study to the development of botanical images. The same lack of method becomes even more conspicuous when the author interrupts his narrative to give us a list of the

1) Some, including the beautiful frontispiece, are not explained at all!

manuscripts of DIOSCORIDES (p. 64-66) or, in another memoir, of those of ALHAZEN (p. 393). (1).

The illustrations are very abundant and generally well chosen though they are not always sufficiently subordinated to the text. Their beauty justifies the very high cost of this book, which on their account will appeal very much to certain *dilettanti*. The author's love of illustrations is so great that he is sometimes led astray by it, as for example when he included pl. XLI, representing the Hall of the GALILEO museum in Florence, a monument of bad taste of which every Italian artist is ashamed

The preface is unpleasant. It is curious that after having taken such pains to edit this splendid volume, SINGER should risk spoiling it all by writing the preface in such a careless way. It is purposed to be a review of contemporary work in the history of science, and SINGER proceeds, so to speak, to distribute good notes to his colleagues of various countries. That may be a generous idea, but if done at all, it should be done very well. SINGER's selection is invidious, for it is far from being comprehensive and, while many smaller names are included, some of the greatest are omitted. Let us hope that this tradition of poor prefaces will be stopped as soon as possible (a preface is not indispensable) and that the *Studies* — which are now to appear annually — will enjoy a long and prosperous life. G. S.

Émile Meyerson. De l'explication dans les sciences. in 8°, 1er vol. XIV + 338 pages; 2e vol. 470 pages. Paris, PAYOT, 1921.

Voici un livre qui fait penser et qui en conséquence doit être lu par ceux que la philosophie et l'histoire des sciences intéressent. L'auteur s'est demandé quelle est la véritable portée de l'explication scientifique, quelle est sa valeur de savoir, dans quelles conditions les savants la recherchent, dans quelles circonstances elle les satisfait ou encore elle les déçoit. Il n'a pas cherché à résoudre ce problème à l'aide d'une théorie de la connaissance posée *a priori* par un système philosophique ; mais en interrogeant habilement les chercheurs de tous les temps et de tous les pays, il a découvert dans la lecture attentive de leurs œuvres les tendances profondes de leur intelligence et de leur volonté qui sont souvent bien différentes des principes méthodologiques que les auteurs déclarent adopter.

Dans le compte rendu d'un ouvrage aussi important, l'on ne peut

(1) An appendix contains a lists of 82 MSS. of Aristotelian biological works in English libraries. That is excellent.

songer ni à suivre pas à pas la pensée de l'auteur ni à discuter ses conclusions. Jetons un coup d'œil sur le point de départ et le point d'arrivée de ses méditations pour apercevoir l'ensemble et nous rendre compte de tout l'intérêt qu'elles présentent.

Il a commencé par établir que, contrairement aux affirmations retentissantes du positivisme, la science ne peut se passer d'attribuer à des « choses » une existence objective. Sous les phénomènes variés, sous les apparences qui nous sont seules accessibles, elle suppose une réalité ontologique persistante. Avec la même fermeté M. MEYERSON montre que — quelles que soient les illusions ou les prétentions des savants — l'esprit humain est incapable de s'arrêter à l'énoncé brut des lois physiques, résumés d'observations empiriques dont nous constatons la validité, mais qui ne s'imposent pas de force à notre raison ; cela ne nous suffit point. Car non seulement notre entendement aspire à savoir ce qu'en fait les choses sont, mais encore il veut être assuré qu'en droit elles ne sauraient être autrement qu'elles ne sont. A la description légale, il a tendance à substituer l'explication causale.

Mais qu'est-ce que l'explication causale ? M. MEYERSON l'étudie dans toutes ses modalités et dans toutes les sciences ; avec une richesse de documentation remarquable il nous la montre déduisant les faits de leurs antécédents, puis, établissant comment ils sont fonction les uns des autres, enfin démontrant — ou aspirant à démontrer — qu'ils sont logiquement nécessaires : bref, que le monde entier est perméable à notre raison.

Pour parvenir à ce résultat, comment procède notre intellect ? Déjà le sens commun substitue à notre vision immédiate et inconsistante du monde sensible des objets plus stables et plus simples qui lui sont équivalents ; la science, l'auteur le montre avec des exemples à l'appui, poursuivant ce travail par une méthode semblable, détruit l'ontologie du sens commun et remplace ses objets par d'autres plus simples et plus stables ; puis, par le même processus, elle remplace cette ontologie par une plus simple. Enfin, avec le mécanisme, elle ne laisse subsister que l'espace et seules les différences entre les figures et les mouvements doivent expliquer les différences entre les choses. Nous aboutissons, cela se voit, à proclamer qu'historiquement et logiquement le conséquent est équivalent à l'antécédent qui le précède et dont il procède. En réduisant notre image du monde à des modifications de l'espace, nous affirmons sa similitude éternelle, nous nions le « devenir » ou tout au moins le nouveau. Mais si nous rendons raison par là du déterminisme de la nature, nous ne sommes pas encore satisfaits ; la diversité dans l'espace doit être expliquée comme la diversité dans le temps. En suivant le penchant de notre raison, nous dissoudrions la

réalité dans l'espace indifférencié, détruisant finalement l'ontologie que nous avions d'abord posée, renonçant en définitive à expliquer le monde dont la diversité ne peut se ramener à l'identique.

C'est que la réalité résiste à la contrainte de notre raison; elle n'y résiste, il est vrai, pas complètement, puisque la science est possible, qu'elle est parvenue dans une certaine mesure à expliquer le réel, et que comme le montre un examen attentif ses efforts pour le rationaliser n'ont pas été entièrement vains. Mais enfin elle y résiste, puisque au terme de ses déductions la science rencontre l'irrationnel qu'elle renonce provisoirement à expliquer! La lecture d'ouvrages scientifiques nous convainc de cette vérité, et l'irrationnel, la science le rencontre souvent là où elle ne le prévoyait pas, elle est obligée de l'accueillir.

Si la science est explicative, elle est loin, ne l'oublions pas, d'être uniquement explicative; elle vise à être une image du réel qui, ainsi que nous l'avons vu, ne pouvant se ramener à l'identique, est par essence inexplicable! Et ces deux tendances de la science qui en un sens sont opposées, antagonistes, coexistent paisiblement dans la science moderne; les principes de conservation, celui de la conservation de l'énergie par exemple, posent l'immutabilité du monde, alors que les irrationnels, le principe de Carnot en particulier, reconnaissent que cette immutabilité est impossible.

Cette opposition, ou, si l'on veut, cette contradiction entre les tendances de la science, ne lui est point particulière; elle se retrouverait dans les systèmes philosophiques ou même dans les affirmations instinctives du sens commun. L'histoire montre qu'elle est aussi ancienne que la science ou que la philosophie, et à cet égard, l'étude de la pensée du passé est aussi instructive que l'étude de la pensée moderne. La raison humaine depuis l'antiquité n'a point varié. — « Tout le monde, toujours, en toute circonstance, a raisonné et raisonne selon un mode essentiellement invariable ». Telle est la conclusion à laquelle aboutit M. MEYERSON. Cette conclusion, il y parvient après avoir écarté les objections des savants et des philosophes, après avoir analysé la logique de HEGEL; chemin faisant il utilise comme documents la pensée d'un grand nombre d'auteurs, qu'il semble pénétrer à fond; son érudition est immense. Mais à l'exception d'un appendice consacré à l'opposition des chimistes aux doctrines de LAVOISIER, les textes des savants sont choisis uniquement afin d'illustrer la thèse de l'auteur; s'il utilise l'histoire des sciences, il ne prétend point faire œuvre d'historien.

Or, l'histoire méthodique des sciences physiques n'est pas encore fort avancée et souvent elle hésite sur sa méthode et sur son but. Parmi les enseignements que l'on peut tirer des livres de M. MEYERSON,

de même que de son ouvrage précédent *Identité et réalité*, un des plus précieux est que cette histoire ne satisfait pas seulement une curiosité, certes légitime, mais stérile : qu'elle peut fournir au philosophe une base lui permettant de mieux connaître la marche de l'esprit humain.

(Paris.) HÉLÈNE METZGER.

Hugo Dingler. PHYSIK UND HYPOTHESE. Versuch einer induktiven Wissenschaftslehre nebst einer kritischen Analyse der Fundamente der Relativitätstheorie; pp. XI + 200. Berlin und Leipzig, Vereinigung wissenschaftlicher Verleger. 1921.

Professor DINGLER's book on Physics and Hypothesis consists of a discussion of the concept of rigid body, of the nature of scientific hypothesis, and of some of the underlying epistemological problems.

All experiment, according to the author, rests on the notion of a rigid body. A rigid body, however, cannot itself be established experimentally. Hence, there can be no such thing as a *purely* experimental physics; hypotheses must be introduced.

The discussion of the nature of hypothesis constitutes the most important part of the book. That the formal architecture of scientific hypotheses, and the interpretations of hypotheses in terms of physical « reality », can best be comprehended by a study of postulational theory and technique as developed so fruitfully in recent years by mathematical logic, is a thesis well worth emphasizing.

The last portion of the book is devoted to a metaphysical attack upon all relativity theories in science.

(*Cambridge, Mass.*) H.-M. SHEFFER.

Stone, Gilbert. A History of Labour. 416 p. London, HARRAP. August 1921. (15 s.)

Mr. STONE, sometime secretary to the British coal industry commission, has written for the general reader a very entertaining and well-informed book It is not meant for special students of the subject, but other students will enjoy it, for, though the author has not carried on any original investigations, he has made good use of some of the best secondary sources and he is remarkably free from prejudice and from those rhapsodical tendencies so common among popular writers on social problems. I do not say that he has no bias, but simply that he is very tolerant and judicial. He rejoices in the emancipation of the masses and in the gradual extension to them of a freedom and happiness which for centuries had remained the privilege of the very few. He thinks that the process of emancipation is far

from being complete, but that it must be slow to be sound, and that, as more power and opportunities accrue to the labouring people, they will of necessity realize more keenly their obligations. He insists, in my opinion very wisely, on the fact that labour problems do not result simply from conflicts of economic interests (p. 216) : « The opposition is not between the worker and the capitalist ; it is between the man who works, who suffers, who experiences, who knows and the man who never works, never suffers, never experiences and never knows.» I would say, in other words, that this opposition is not only a conflict of material interests, but is also to a degree but another face of the old conflict between ignorance and superstition on the one hand and scientific knowledge and method on the other And this concerns us directly : Social progress is a function of the progress of knowledge ; it is our business and duty to prove it.

The subject of Mr. STONE's book is at once less and more comprehensive than the title suggests. It is not international, but largely restricted to England. It is true, the first chapter deals with Roman slavery and mediaeval serfdom, but that seems a proper introduction. There are also not a few references to conditions in France and the United States, but not more than one would expect in any history of British labour for the purpose of comparison and explanation. For example, the French Revolution marks an important date in English history, and it influenced social problems in England just as the Russian Revolution is now affecting them — and will affect them more and more — in one way or another, all over the world. On the other hand, to illustrate the gradual improvement in the condition of workmen, Mr. STONE has thought it well to explain the contemporary progress in politics and education. His way of limiting and treating the subject seems to me to be adequate to the aim of his book.

After having surveyed the progress accomplished down to our day, the author quotes, with evident pleasure, MACAULAY's conclusion : « The more carefully we examine the history of the past, the more reason shall we find to dissent from those who imagine that our age has been fruitful of new social evils. The truth is that the evils are, with scarcely an exception, old. That which is new is the intelligence which discerns and the humanity which remedies them. » This is very true, yet such complacency should not be encouraged, for it is not conducive to further advance. It serves no useful purpose to think of how good we are ; it is better to realize more keenly our deficiencies and strive to correct them. Whatever social progress has been made we owe, not to the self-satisfied optimists, but to those who saw clearly the evils of their time and kicked vigorously until they were eradicated. GEORGE SARTON.

John Koren (*editor*). **The History of Statistics. Their development and progress in many countries. Memoirs to commemorate the seventy-fifth anniversary of the American Statistical Association.** XII + 773 p. New-York, MACMILLAN, 1918.

The American Statistical Association having decided to mark its seventy-fifth anniversary by « a serviceable contribution to our knowledge of statistics », invited the leading statisticians of many civilized countries to explain the development of their respective national statistics, and has published their reports in the present volume which will remain a historical monument of the first order. Truly this is not a history of statistics, which is still badly needed, but it will offer to the future historian of this fundamental discipline a very valuable collection of materials and will enable him to reach easily a great deal of additional information.

It is interesting to note that the American Statistical Association was founded as early as 1839 (at no. 15 Cornhill, Boston). Its objects had been very broadly defined : « to collect, preserve and diffuse statistical information in the different departments of human knowledge ». Its first foreign member was ADOLPHE QUETELET. The signification of these early efforts will be better appreciated if one realizes that in 1839, there were only two other similar organizations in existence, the Manchester Statistical Society founded in 1833 and the London (now Royal) Statistical Society founded in 1835. The Journal of the London Society began to appear in 1838, — but the British Annual Register was born as early as 1758. The Statistical Abstract of Great Britain dates of c. 1855 ; it was the first of the many national annuals now published. The Statistical Abstract of the U. S. dates of 1878. The New-York Tribune Almanac dates of 1838.

No nation spends more money and energy in the compilation of statistics than the United States, but, as S. N. D. NORTH has remarked, it is certain that much of the expenditure is wasted. The Constitution ordained that a census of the population be taken in 1790 and every tenth year thereafter, and this has been done faithfully, with increasing comprehensiveness and accuracy. It is interesting to note that it was just a century later, in 1890, that ROBERT P. PORTER, director of the Eleventh Census, introduced the automatic tabulation : a technical progress of enormous scope. To the federal statistics must be added those undertaken by the 48 separate states and by private organizations (for ex. insurance societies of tremendous power). It is then perhaps less astonishing that the American association is one of the oldest of its kind in the world.

KOREN's History is divided as follows. An introductory article by

himself relates the history of the association. S. N. D. NORTH gives a rapid survey of the progress of statistics since 1839 and shows the outlook for the future. Then follow a series of memoirs explaining the development of statistics in fifteen different countries :

Australia, by GEORGE HANDLEY KNIBBS,
Austria, by ROBERT MEYER,
Belgium, by ARMAND JULIN,
Canada, by ERNEST H. GODFREY,
Denmark, by ADOLF JENSEN,
France, by FERNAND FAURE,
Germany, by EUGENE WÜRZBURGER,
Great Britain and Ireland, by Sir ATHELSTANE BAINES,
Hungary, by LADISLAUS VON BUDAY,
India, by Sir ATHELSTANE BAINES,
Netherlands, by C.-A. VERRIJN STUART,
Norway, by A.-N. KIAER,
Russia, by A. KAUFMANN,
Sweden, by EDVARD AROSENIUS,
United States, by JOHN CUMMINGS (federal stat.) and CHARLES F. GETTEMY (state stat.).

(The absence of reports relating to Italy and Japan is not due to the editor's negligence, as such reports had been promised to him respectively by C. A. ASCHIERI and S. TAKARABE, — but I find no mention of the great South American republics !)

It is impossible to summarize these reports, which are very full. They are also very unequal, a circumstance which it is easier to deplore than to avoid. The longest report is the one dealing with the United States (167 p.), then follow the French report (117 p.), the Russian (69 p.), the Belgian (55 p.), the Austrian (41 p.) etc. An elaborate index makes it easy to use this excellent book for the solution of particular problems,

This survey of the progress of statistics in various parts of the world was accomplished at the most suitable time, for it is safe to assume that the Great War closes an old period and opens a new one. May we hope that the new era will see a new development of international statistics ? This is of course an ambitious dream — for international statistics imply international comparability, and comparability implies unification of methods. The problems to be solved are numerous and very complex, and complete unification will be difficult to accomplish. Yet it is only to the extent that international statis-

tics are realized that it will ever be possible to appreciate accurately human welfare and progress, and to prepare a scientific history of social endeavours. The International Statistical Institute, founded in 1885 (1), may become a powerful agency to attain this aim : its efforts should be encouraged and its power strengthened by all means.

G. SARTON

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(1) Apropos of this see the Annuaire de la Vie Internationale, vol. II, Bruxelles 1910-11, p. 1059-65, also NORTH's article above-mentioned, p. 47. Nine statistical congresses were held from 1853 to 1876, the first in Brussels, the last in Budapest. The International Institute was founded at the London Statistical Jubilee of 1885, and has held biennal meetings at least until the war. The publication of its Bulletin began in 1886.

Eleventh Critical Bibliography

of the History and Philosophy of Science and of the History of Civilization

(to October 1921)

This Eleventh Bibliography contains about 411 notes, of which a few have been contributed by L. Guinet (Brussels). The arrangement and leading principles of this bibliography have been fully explained in volume III, 159-171; a complete plan of classification will be found also in the present volume, p. 124-125. The reader will keep in mind that Part I is the fundamental classification (centurial) and that Parts II and III contain only such items as could not be included in Part I.

As this bibliography appears only twice a year, I beg the authors to take pains that books and papers on the history and philosophy of science and the history of civilization, be sent to me as soon as they are published. Even then almost a year may elapse before they are included.

The aim of this bibliography is to establish the History of Science as an independent discipline and to serve as a center of information and a rallying ground to the scholars engaged in these studies. I can not succeed entirely without their assistance, and they can help me in many ways. To serve them, as well as I can, is both my duty and my pleasure. Critical work must be approached in a spirit of service or left untouched.

24, Agassiz Street,
Cambridge, Massachusetts,
October 1921.

George Sarton.

Authors' Index.

The Roman figures refer to centuries, the other words, as *China*, *astronomy*, etc., refer to the sections of Parts II and III bearing these titles. The index will enable one to find more easily the papers analyzed in the present bibliography, and also to see at a glance what everybody is doing.

ELIZABETH GILPATRICK.

A

Adriani, N., Ethnology.
Amodeo, F., XVIII, XIX A.
Andel, M. A. van, XVI, Medicine B.
Andersson, J. G., China.
Andrews, F. H., China.
Andrup, O., XVII.
Arber, E. A. N., Botany.
Arrhenius, S., Astronomy.
Avalon, J., XVIII.

B

Bachmann, P., XVII.
Backer, H. J., Chemistry.
Barbezieux, G., Medicine B.
Bartholin, C. T., XVII.
Bates, O., Archaeology, Egypt.
Battistini, M., XIV.
Beazley, C. R., Middle Ages.
Beazley, J. D., VI A. C.
Bein, W., Chemistry.
Bell, E., Greece.
Berg, W. S. van den, XII.
Bezold, C., II A. C.
Bianchi, L., Greece.
Bidez, J., IV.
Bigourdan, G., XVII, Astronomy.
Bilancioni, G., XV.
Binyon, L., India.
Blok, P. J., XVI.
Bloomfield, M., India.
Boeke, J., XVI.
Boerhaave, H., XVIII.
Boll, F., I.
Bonnet, E., XVIII.
Boulenger, J., XVII.
Bragg, Sir W., Physics.
Brimhall, D. R., Science B.
Broodbank, Sir J. G., Economics.
Brulez, L., Philosophy.
Buchholz, H., XIX B.
Buller, A. H. R., Botany.
Burkitt, M. C., Prehistory.
Burr, C. W., XVIII.

C

Cabanès, A., History.
Cajori, F., III A. C., XIX B.
Campbell, N. R., Science D.
Capelle, W., Greece.
Carõe, K., XVII.
Carpocino, J., III.
Casanowicz, I. M., Religion.
Castiglioni, A., XVII.
Cattell, J. McK., Science B.
Chauveau, XIX C.
Child, J. M., III A. C.
Cleu, H., Medicine B.
Cole, F. J., Anatomy.
Collard, A., Astronomy.
Conybeare, F. C., XII.
Cordier, H., China.
Crane, T. F., Middle Ages.
Croce, B., History.
Cumston, C. G., XVI, XVIII.
Cyriax, R. J., Medicine A.

D

Dahlgren, E. W., XVIII.
Daniëls, C. E., XVII, XVIII.
Dannemann, F., Astronomy.
Davis, A. McF., China.
Delaunay, P., XVIII.
Deonna, W., Archaeology.
Diels, H., IV A. C., II A. C.
Dieulafoy, M., Antiquity.
Diez, E., Iran.
Dorveaux, P., XVI.
Dreyer, J. L. E., Middle Ages.
Driesch, H., Science D.

E

Ebersolt, J., Byzantium.
Eckleben, W., XI.
Endrös, A., IV A. C., Geography.
Enestrom, G., XIII.
Erdmann, B., XVIII.

F

Faddegon, B., India.
Fahie, J. J., XVII.
Favaro, A., XVI.
Fehr, H., XVIII.
Feltse, C. L., IV.
Feyfer, F. M. G. De, XVI, Medicine A.
Fleming, D. J., India.
Fog, R., VIII.
Foote, J., Medicine A.
Fosseyeux, M., Medicine A.
Foster, W., XVI.
Fuertes, L. A., Zoology.

G

Garboe, A., XVII.
Garrison, F. H., Medicine A.
Giles, H. A., China.
Ginzel, F. K., Astronomy.
Gleichen-Russwurm, A. v., Middle Ages.
Goldziher, I., Islam.
Goulard, R., XVII, XIX E.
Graeven, H., XVII.
Gregory, J. W., Geology.
Grennep, A. van, Egypt.
Griffini, E., VIII.
Griffis, W. E., Japan.
Groot, J. J. M. De, China.
Guelliot, O., Rome.
Günther, S., Astronomy, Ethnology, Greece.

H

Haarhoff, T., IV.
Haentzschel, E., III.
Hagedoorn, A. L., Biology.
Hagedoorn-Vorstheuvel La Brand, A. C., Biology.
Haldane, J. S., Biology.
Hamburger, O., Egypt.
Hammer Jensen, M^{me} I., III.
Hara, K., Japan.
Harding, M. C., XIX B.
Hardwick, J. C., Religion.
Harris, D. F., II.
Hartland, E. S., Ethnology.
Haskins, C. H., XIII.
Haug, E., Geology.
Hauser, F., XIII.
Hellweg, H., XVI.
Hemmeter, J. C., XVI.
Herrmann, A., China.
Hervey, M. F. S., XVII.
Herwerden, M. A. van, XIX C., XIX D.
Herzog, M. A., Education.
Hess, J. J., Islam.
Hirth, F., China.
Holl, M., XVI.
Holleman, A. F., XIX B.
Holmes, A., Geology.
Hooton, E. A., Egypt.
Hoppin, J. C., VI A. C.
Hopstock, H., XV.
Hough, W., Ethnology.
Housman, A. E., I.
Hülle, H., China.
Hume, R. E., India.
Hunger, F. W. T., XVI.

J

Jacobs, K., Bibliography.
Jäger, F., XIII.
Janet, P., Medicine A.
Jaussen (et Savignac), Islam.
Jeanselme, E., IV, Antiquity, Byzantium, Middle Ages.
Jenkinson, J. W., Science D.
Jéquier, G., Egypt.
Johnson, E. H., Science B.
Johnsson, J. W. S., XIII, XVII, Medicine A.

K

Karpinski, L. C., XIX B.
Kaye, G. W. C., Science C.
Kennedy, J., I.

Kleij, J. J. van der, XVI.
Kleiweg de Zwaan, J. P., Ethnology.
Knappert, L., XVI.
Krause, E., V. A. C.
Krause, F. C. A., XIV.
Kreemer, J., jun., Ethnology.
Kremer, A. von, Islam.
Kroner, R., XII.

L

Laby, T. H., Science C.
Lacroix, A., XVIII, XIX C.
Lane, J. E., XVIII.
Lang, R., XVII.
Langdon, S., Babylonia.
Lange, E. F., XIX B.
Lanman, C. R., V.
Lavignac, A., Art.
Lecat, M., Mathematics.
Leclerc, H., XVI, XVII, Botany, Pharmacy, Superstition.
Leersum, E. C. van, XVI, XVII, XVIII.
Lint, J. G. de, XVI, XVIII, Medicine B.
Lippmann, O. von, Chemistry.
Little, A. G., Religion.
Loeschcke, S., I.
Loewenfeld, K., XVIII.
Loghem, J. J. van, XVII.
Lorenzo, G. de, XV.
Loria, G., XIV, Mathematics.
Lucas, F. A., XIX E.
Luce, S. B., Greece.
Lumière, A., XIX B.
Lumière, L., XIX B.
Lundsgaard, K. K. K., XVII.
Lungo, C. Del, XVII.
Lutaud, A., XIX D.
Lützhöft, F., Medicine A.

M

Maar, V., XVII.
Macdonald, D. B., Bible.
Manly, J. M., XIII.
Marvin, F. S., Science D.
Mascart, J., XVIII.
Matschoss, C., Science B.
McClure, M. L., IV.
McClymont, J. R., Zoology.
McMurrich, J. P., XV.
Means, P. A., Art.
Menetrier, P., Middle Ages.
Menke-Glückert, E., XIX D.
Merz, J. T., Philosophy.
Meyer, K., XIX B.
Meyerhof, M., Islam, Pharmacy.
Michaud, F., Physics.
Mills, J., Science C.
Moïssides, Greece.
Molhuysen, P. C., XVII.
Montgomery, D. W., XVI.
Moodie, R. L., Prehistory.
Moulé, Léon, Antiquity.
Moureu, C., Chemistry.
Moutier, F., XVII, XVIII.
Mühll, P. von der, IV A. C.
Mygind, H., Rome.

N

Nagl, A., Antiquity.
Nass, L., XIX E.
Neergaard, C., XVII.
Neuburger, A., Antiquity.
Neumann, C., XIX B.
Neveu, R., Antiquity, Greece.
Nilsson, M. P., Ethnology, Greece.
Norlind, A., Geography, Middle Ages.

O

Ojha, G. H., India.
Oldenberg, H., India.

P

Paoli, H. J., XVI.
Parker, G., Medicine A.
Parodi, D., XIX E.
Passerini, G. L., XIV.
Peachey, G. C., XVII, XVIII.
Pergens, E., Medicine A.
Pino y Roca, J. G., Medicine A.
Platt, A., IV. A. C.
Pleadwell, F. L., XIX D.
Poggi, G., XV.
Pogue, J. E., Geology.
Poincaré, R., XV.
Poole, R. L., Middle Ages.
Poor, C. L., Mechanics.
Porter, A. K., XII.
Prutz, H., Middle Ages.

R

Rambaud, P., XVII, Medicine A.
Redgrove, H. S., Superstition.
Regnault, F., XV.
Rehm, A., Greece.
Reinhardt, H., Middle Ages.
Reismüller, G., China.
Rey, A., Physics, Science B.
Richet, C., XIX C.
Richter, H., IV.
Ritter, P., XVII.
Riviere, E., Superstition.
Roberts, M., Physiology.

Robertson, J. M., Morals.
Rolleston, J. D., II, XVIII, Greece.
Roscher, W. H., Greece, Religion.
Rosenbloom, J., XVI, XIX D.
Roth, F. W. E., XII.
Roy, P. G., XVII.
Rufini, E., IV A. C.
Ruge, W., Geography.
Ruhräh, J., XVI, XVII, Medicine A.

S

Sagher, D., XIV.
Saintyves, P., Medicine A., Superstition.
Salza, L., XVIII.
Saussure, L. de, China.
(Jaussen et) Savignac, Islam.
Scheffer, H., XIV.
Scheil, Le P., Babylonia.
Scheil, V., Babylonia.
Schelenz, H., XVI.
Schiller, F. C. S., Science D.
Schindler, B., China.
Schlosser, J. von, Art.
Schoff, W. H., I.
Schoy, C., X.
Schramm, E., II A. C.
Schuchert, C., Geology.
Schück, A., Astronomy.
Schwarte, M., XX.
Schwarz, I., Medicine B.
Schwarz, O. L., Psychology.
Segalen, V., V.
Sethe, K., Antiquity.
Seybolt, R. F., XV.
Singer, C., Biology, Physics.
Sirks, M. J., XVI.
Slaby, A., XVII.
Smith, D. E., XVI, Mathematics.
Smith, E. C., XVIII.
Smith, E. F., XVIII.
Smith, V. A., III A. C.
Smith, W. W., Psychology.
Soddy, F., Science C.
Soreau, R., Mathematics.
Soutzo, M., Antiquity.
Steele, J., China.
Steele, R., XIII.
Stefanini, G., XVII.
Sterns, F. H., Egypt.
Stevenson, M. C., Ethnology.
Stevenson, Mrs.(Margaret) S., India.
Stevenson, W. B., Islam.
Stieda, W., XVII.
Stimson, D., Astronomy.
Stoddard, L., History.
Streeter, E. C., Medicine B., Middle Ages.
Strong, Mrs. A., Rome.
Sudhoff, K., XV, XVI, Medicine A.
Suter, H., IX, XI.

T

Tandberg, J. G., XVII, XIX B.
Thiset, A., XVII.
Thomas, A., XIII.
Tieghem, P. van, XIX B., XIX C.
Toni, G. B. de, XVIII.
Torkomian, V. H. XV, Medicine A.
Toynbee, P., XIV.
Tropfke, J., Mathematics.
Trotz, T., II.
Tyler, J. M., Prehistory

V

Vecchio-Veneziani, A. Del, XIX E.
Venturi, A., XV.
Vetter, Q., Mathematics.
Vidyabhusana, M. M., India.
Villaret, M., XVII, XVIII.
Vloten, G. van, IX.
Vollgraff, J. A., Mechanics.

W

Wageningen, J. van, Physiology.
Wagner, H., XVI.
Waley, A., Japan.
Watson, F., Education.
Weindler, F. Medicine A.
Wensinck, A. J., Geography.
Wetter, G. P., Religion.
Weyl, H., XIX A.
Wiberg, J., X.
Wickersheimer, E., XIII, XVI, Middle Ages.
Wiedemann, E., IX, XI, XII, XIII, XIV, Islam.
Wilamowitz-Moellendorff, U. v., IV A. C.
Withington, E. T., Greece.
Wolfson, H. A., Israel.
Wollaston, A. F. R., XIX C.
Wood, C. A., Medicine A.
Wood, P., Bible.

Y

Yerkes, R. M., XX.
Young, G. W., Geography.

Z

Zervos, C., XI.
Zeuthen, H. G., Greece.

PART I.

Fundamental Classification (centurial).

S. VI A. C.

Beazley, John Davidson. Attic red-figured vases in American museums. x + 236 p., 118 fig. Cambridge, Mass. Harvard University Press, 1918. ISIS

The vases dealt with date from the end of the sixth century to the end of the fifth or the beginning of the fourth, — in other words from the work of the ANDOKIDES painter (one of the first artists to use the red-figured style) to the Meidias hydria. There are abundant references to the non-American vases. G. S.

Hoppin, Joseph Clark. A handbook of Attic red figured vases signed by or attributed to the various masters of the sixth and fifth centuries B. C. Cambridge, Harvard University Press, 2 vol. XXIV + 472 p., VIII + 600 p., 1919. ISIS

An elaborate *catalogue raisonne* with many illustrations and copious indexes. The order adopted by the author is the alphabetical order of painters and potters, and secondarily the alphabetical order of museums. No attributions have been included unless some scholar has definitely assigned a given vase to a certain hand; the author himself has not added attributions of his own except when obliged to choose between conflicting attributions. The illustrations are small but very good. G. S.

S. V A. C.

Krause, Ernst. DIOGENES von Apollonia. *Janus* 1909, 228-241, 570-584; 1914, 380-384; 1915, 314-326, 505. ISIS

S. IV A. C.

Diels, H. Über PLATONS Nachtuhr. *Sitzungsber. d. Kgl. preuss. Akad. d. Wiss.*, J. 1915, p. 824-830. Berlin 1915. ISIS

« Ich halte die gut bezeugte Ueberli-ferung, dass die erste Weckeruhr von PLATON konstruiert worden ist, für ebenso wichtig wie die Nachricht des APOLLONIOS über den Flötenspieler des ARCHIMEDES... ». A propos of a fragment of ATHENAEUS, IV, p. 174 DIELS tries to reconstruct this clock. G. S.

Endrōs, A. Die Gezeiten, Seiches und Strömungen des Meeres bei ARISTOTELES. *Sitzungsber d. bayer. Ges. d. Wiss., math. phys. Kl.*, München 1915, 355-385. ISIS

This paper is a sequel to the author's previous one on the Euripus question (*Isis*, IV, 442). ARISTOTLE had solved this question in the same way as F.-A. FOREL! For he knew the phenomenon called *seiche* and its causes. He also knew that the waves are caused by the wind and by the quaking of the Earth. He could understand the Euripus currents, but not the mysterious tidal anomalies near Chalcis. It is an error to believe that he conceived the tides as a respiration of the Earth. G. S.

Mühll, Peter Von der. Epikurs κύριαι δόξαι und Demokrit. Festgabe Adolf Kaegi, Frauenfeld, 1919, p. 172-178. 1818

Platt, Arthur. Aristotle on the Heart. *Studies in the history of science*, vol. II, 521-532. Oxford 1921. 1818

Rufini, Enrico. Gli studi geometrici di Eudosso da Cnido *Archivio di storia della scienza*, vol. II, 222-239, Roma 1921. 1818

A careful survey of Eudoxus' geometrical work. The author concludes that this work marked the beginning of a new era; with him, geometry ceased to be empirical and tentative. His generalization of the theory of proportion extended the field of geometry into regions hitherto unexplored; his method of exhaustion offered a new instrument of research and of proof and stopped for a while vain discussions on infinity. G. S.

Wilamowitz-Moellendorff, Ulrich von. Platon, 1. Bd. Leben und Werke; 2. Bd. Beilagen und Textkritik VI + 756 p., 452 p. Berlin, Weidmann, 1919. 1818

S. III A. C.

Cajori, Florian. Euclid of Alexandria and the bust of Euclid of Megara. *Science*, vol. 53, 414. 1921. 1818

The bust of Euclid of Megara as represented on a Greek coin has been often mistaken for that of Euclid, the mathematician. The same mistake occurs in the « Portfolio of portraits of eminent mathematicians » edited by D.-E. Smith in 1896 for the Open Court Company. G. S.

Child, J.-M. Archimedes' principle of the balance and some criticisms upon it. *Studies in the history of science*, vol. II, 490-520, 25 fig Oxford 1921. 1818

Elaborate criticism of Mach's interpretation of Archimedian statics. G. S.

Smith, Vincent A. Asoka. The Buddhist emperor of India Third edition revised and enlarged. 278 p., illustr. Oxford, Clarendon Press, 1920 (first ed. 1901; 2d ed. 1909). 1818

S. II A. C.

Bezold, C Sze-ma Ts'ien und die babylonische Astrologie. Hirths Festschrift, Berlin 1920, 42-49. 1818

According to Bezold the Chinese became acquainted with Babylonian astrology probably before 523 B. C. and adapted it to the conceptions which they had already independently developed. He makes a comparison between the Babylonian constellations and those quoted by Ssŭ-ma Ch'ien. G. S.

[Philo of Byzantium]. Exzerpte aus Philons Mechanik B. VII und VIII (vulgo fünftes Buch). Griechisch und Deutsch von H. Diels und E Schramm *Abhdl. d. preuss Akad. d. Wiss., philos.-histor. Kl.*, J. 1919. 84 p. Berlin 1920 1818

This so-called fifth book (since Thévenot) of Philo's Μηχανικὴ σύνταξις is really a collection of extracts from book VII, Παρασκευαστικά and book VIII, Πολιορκητικά. The text now published is based upon the original text edited by Richard Schöne. The authors have also availed themselves of the notes by Ernst Fabricius, 1886, kept in Ms. in Berlin. There is a technical introduction of 14 pages. G. S.

S. I.

Boll, Franz. Aus der Offenbarung Johannis. Hellenistische Studien zum Weltbild der Apokalypse. (*Stoicheia*. Studien zur Geschichte des antiken Weltbildes und der griechischen Wissenschaft, 1) VIII + 151 p. Leipzig, Teubner, 1914. 1818

Hellinistische Prophezeiungen. Das Weltbild der Apokalypse. Schalen- und Posaunenvision und ihre Quelle. Das erste Wehe. Die apokalyptischen Reiter. *Regina caeli.*

Kennedy, J. Eastern Kings contemporary with the Periplus. *Journal of the R. Asiatic Society*, London 1918. 1818

Criticism of Schoff's paper quoted below. The *Periplus* is the result of many years' experience; it was written in colloquial Greek to be a vade mecum for Roman sea-captains trading with the East. It was written in Malichas' time and is of a single web and woof throughout (Malichas was king of the Nabataeans until A. D. 71). G. S.

Loeschcke, Siegfried. Lampen aus Vindonissa. Ein Beitrag zur Geschichte von Vindonissa und des antiken Beleuchtungswesens. 358 p. f°, 23 pl. Zürich, Beer. 1919. 1818

An exhaustive study of the rich collection of lamps found in Vindonissa (= Windisch). It contains about 1100 specimens and is likely the largest collection found in any place beyond the Alps. They date of the first century. G. S.

[Manilius], M. Manilii Astronomicon. Liber quartus. Recensuit et enarravit A.-E. Housman. XVIII + 130 p. London, Grant Richards, 1920 [not seen]. 1818

See *Isis* III, 94. G. S.

Schoff, Wilfred H. The date of the Periplus. *Journal of the R. Asiatic Society*, 1917 (2) 827-830. 1818

Schoff adopts the conclusions previously reached by General M.-R. Haig: The author made his voyages at various times between 65 and 75 or 80 A. D. The work was written in the last quarter of the first century. See Kennedy, supra. G. S.

S. II.

Harris, D. Fraser. On a Latin translation of the complete works of Galen by Andrea Laguna, M.-D., the Spaniard, Strassburg, 1604. With notes, dedications, a life of Galen and index. *Annals of medical history*, II, 384-390. New-York, 1919. 1818

In the Library of the Faculty of Medicine, Dalhousie University, Halifax, N. S. This is the 4th ed. of the series of 5 ed. of Laguna's Galen, the first being dated 1548, the 5th, 1643. Andrea Laguna or Lacuna, 1499-1560. G. S.

Rolleston, J.-D. Lucian and medicine. *Janus*, t. 20, 83-108. Leyde 1915. 1818

Lucian's writings contain many allusions to prevalent diseases, especially pneumonia, consumption, alcoholism, gout and fevers (malaria, typhus, typhoid, Malta fevers); no evidence suggestive of syphilis. G. S.

Trotz, Theodor. Der Inhalt der Dresdener lateinischen GALEN handschrift aus dem Anfange des 15 Jahrhunderts. Erster Abdruck der « Oeconomica GALENI » (*Diss*, SUDHOFF's Institut, Auszug). 14 p. Leipzig 1921. 1818

This Dresden Ms. is famous for its miniatures, but the texts it contains are equally important. One of the translators is often quoted, NIC. DA REGGIO, who fl. in Calabria in the XIVth cent., — but there were other translators and it is unlikely that NIC. DA REGGIO translated GALEN from the Arabic as the scribe says. This Ms. is analyzed and the text of the following part edited : YCONOMICA GALIENI translata ab ARMENGANDO BLAZII de arabico in latinum in Monte Pessulano, continet IIII capitula (de diviciis servandis, de servis, de uxore, de filiis). G. S.

S. III.

Carpocino, J. La table de mesures des « Mediani ». *Comptes rendus de l'Académie des inscriptions*, 1919, p. 379-387. 1818

A propos d'un autel primitivement dédié à l'empereur MAXIMIN († 258) et converti après sa mort en table de mesures de capacités (deux mesures d'environ 9 et 5 litres). Trouvé en 1918 dans la plaine de Sétif, aux Ouled-Abdallah, à 10 kilomètres Sud-Est de Saint-Arnaud. G. S.

Haentzschel, E. Lösung einer Aufgabe aus der Arithmetik des DIOPHANT. *Jahresbericht der deutschen Mathematiker-Vereinigung*, t. 24, 467-471, Leipzig 1916. 1818

That is, book III, problem 7 (TANNERY's edition, 1893, p. 150-153). G. S.

Hammer Jensen, Mme. Ingeborg. Deux papyrus à contenu d'ordre chimique, *Bulletin de l'Acad. royale de Danemark*. Copenhagen 1916, p. 279-302. 1818

Étude sur le Pap. X de Leyde et le Pap. Holmiensis, le premier publié par LEEMANS en 1885, et traduit et commenté par BERTHELOT en 1888; le second — qui est de la même provenance et de la même date — ne fut publié que par LAGERCRANTZ en 1913 : ce sont deux monuments fondamentaux pour l'étude de la technologie dans l'Égypte romaine (Cfr. *Isis*, III, 320). G. S.

S. IV.

Bidez, J. La jeunesse de l'empereur JULIEN. *Bull. de l'Académie royale de Belgique (cl. des lettres)*, Bruxelles 1921, 197-216. 1818

Analyse pénétrante du caractère si complexe de JULIEN : « chrétien par ses premières croyances, mais pénétré d'idées païennes par ses études littéraires; plein d'admiration pour le génie de la Grèce ancienne, mais moderne et presque romantique par le sentimentalisme avec lequel il se reportait vers le passé et aussi par l'importance qu'il attachait aux mouvements de son âme inquiète et ardente »... « JULIEN fut surtout un homme de foi et rien ne ressemble plus à certains égards aux effusions de piété dont ses discours sont remplis que le lyrisme — déjà si moderne — des *Confessions* de SAINT AUGUSTIN ». G. S.

Haarhoff, Theodore. Schools of Gaul. A study of Pagan and Christian education in the last century of the Western Empire. XII + 272 p. Oxford University Press, 1920. 1818

A very interesting study based on original authorities, by a South African

scholar now professor at the University of Cape Town Education in Gaul during the 4th and 5th cent. had not been studied thus far, though it is of great interest for many reasons : it was a period of crisis, education passing through the last stage of official paganism. Yet in spite of the conflicts between Pagan and Christian, Roman and Barbarian, the educational traditions of Rome preserved continuity. The very complexity of conditions (nationality, language) obtaining in Gaul caused her finally to become the leader of the Roman empire in education. Plan : I. Introductory (Greek, Celtic, Germanic influences ; Romanization of Gaul ; early Roman education in Gaul) ; II. Pagan education (Inside the school ; outside of it) ; III. Christian education ; IV. Certain educational ideas and influences (moral education, history ; position of Greek ; art) ; V. Decline of education (Gallic students abroad ; invaders ; ideals). Select bibliography. G. S.

Jeanselme, E. Le chancre mou existait-il à Alexandrie au IV^e^ siècle de l'ère chrétienne? *Bull. soc. franç. hist. méd.*, t. 14. 233-238. Paris 1920. 1819

A propos de PALLADE *Hist. Lausiaca* in MIGNE, *Patrol. graec.*, t. 34, col. 1091 sq. — MÉNÉTRIER a fait remarquer que CELSE avait déjà fort bien décrit les ulcérations phagédéniques des organes génitaux, — mais pas plus que ses prédécesseurs grecs il n'avait mentionné leur origine vénérienne. Dans l'histoire racontée par PALLADIUS cette origine est mise en évidence. G. S.

McClure, M.-L. and Feltoe, C.-L. The pilgrimage of ETHERIA . XLVIII + 103 p. London, Society for the promotion of Christian knowledge, 1920. 1818

English transl. of the text translated into German by H. RICHTER. See below. G. S.

Richter, Hermann. Pilgerreise der AETHERIA (oder SILVIA) von Aquitanien nach Jerusalem und den heiligen Stätten von Jahre 385 n. Chr.). Gefunden in Arezzo von GAMURRINI und 1884 von ihm in Rom hrg. Ins Deutsch übersetzt und mit Einleitung und Anmerkungen versehen. Mit 2 karten, 1 Plan. u. 8 Ansichten. VIII + 102 p Essen, BAEDEKER, 1919. 1818

If this pilgrimage dates back to 385 it is one of the very oldest of which we have a record. The oldest Latin record of such a pilgrimage is the *Itinerarium Burdigalense*, A. D. 333 and it is very meager ; the next is the *Peregrinatio* AETHERIAE, here translated ; then follow : EUCHERIUS c. 450 ; THEODOSIUS c. 530 ; ANTONINUS PLACENTINUS Martyr or Piacenza Anonymus, c. 580 ; ADAMNANUS, d. 704 ; BEDA VENERABILIS, c. 750 ; PETRUS DIACONUS, c. 1137. — However WEYMANN (1908) and KARL MEISTER (1909) have claimed that the *Peregrinatio* AETHERIAE dates only of the VIth cent. The author states clearly their arguments in his Introduction, and discusses them ; he himself is convinced that the date formerly indicated by GAMURRINI, c. 385, is the correct one. At any rate, whether the account of this pilgrimage dates of the IVth or the VIth cent., it is extremely interesting. G. S.

S. V.

Lanman, Charles Rockwell BUDDHAGHOSA's treatise on Buddhism, entitled the Way of Salvation. Analysis of Part I, on Morality. *Proc. of the American Acad. of Arts*, vol. 49, p. 149-169, Boston 1913. 1818

The *Visuddhi-magga* was written in Pali at the Great Monastery of

Ceylon in or ab. 410 A. D.; it is one of the most authoritative books on Buddhism. LANMAN is completing an edition and transl. of it, undertaken by his late friend H.-C. WARREN. G. S.

Segalen, Victor. Sépultures des dynasties chinoises du Sud (Epoque des NAN-PEI-TCH'AO, Ve et VIe siècle après J. C.). *Comptes rendus de l'Acad. des inscriptions* Paris 1917, p. 241-259, 12 fig. 1818

S. VIII.

Fog, Reginald. Der Unholt - Grendel » in BJOVULF. *Janus*, t. 23, 159-166, Leyde, 1918. 1819

[Zaid ben Ali.] Corpus Juris di ZAID IBN ALI (VIII Sec. cr.). La più antica raccolta di legislazione e di giurisprudenza musulmana finora ritrovata. Testo arabo pubblicato per la prima volta sui manoscritti Jemenici della Biblioteca Ambrosiana con introduzione storica, apparato critico e indici analitici da EUGENIO GRIFFINI, Dr. Jur. In-4° pice., CXCVIII + 420 p. Milano, HOEPLI, 1919. 1818

See a study by the same author on ZAID IBN ALI and his code in the *Rend. Ist. Lomb. d. sci. e litt.*, t. 44, 1911. 16 p. G. S.

S. IX.

Suter, Heinrich. Über die Ausmessung der Parabel von THĀBIT B. KURRA AL-HARRĀNĪ. *Sitzungsber. d. physik. medizin. Sozietät*, t. 48, 65-86, Erlangen 1918. 1819

Contains the translation of the text from a Paris Ms. (DE SLANE, Ms. 2457, 25°) with commentary. G. S.

Suter, Heinrich. Die Abhandlungen THĀBIT B. KURRAS und ABŪ SAHL AL-KŪHĪS über die Ausmessung der Paraboloide. *Sitzungsber. d. physik. mediz. Gezell.*, t. 48, 186-227, Erlangen 1918. 1818

SUTER translated previously a memoir by IBN AL HAITHAM (965-c. 1039) on the mensuration of the paraboloid (*Bib. math.*, t. 12, 289-332, 1912). In that work IBN AL HAITHAM recalled two other works on the same subject, one by the Sabaean THABĪT B. KURRA (826-901), the other by the Persian WAIDJAN B. RUSTEM AL-KŪHĪ (fl. 980-1000). SUTER now publishes translations of these works with commentary, concluding that they (and IBN AL HAITHAM'S work) are among the choicest fruits of Arabic mathematics : they form, so to say, a transition between the investigations on infinitesimal geometry of ARCHIMEDES and those of LUCA VALERIO, CAVALIERI, KEPLER and WALLIS. G. S.

Vloten, G. van. Ein arabischer Naturphilosoph im 9. Jahrhundert (EL-DSCHĀHIZ). Aus dem Holländischen (mit einigen Zusätzen) übertragen von O. RESCHER. 47 p. Stuttgart, W. HEPPELER, 1918. [60 copies.] 1818

The Dutch text appeared in May 1897, in the *Tweemaandelijksch Tijdschrift*. 'AMR IBN BAHR, surnamed AL-JAHIZ (the goggle-eyed) died in 255-868, being more than 90 years old; he lived at Bassora and wrote among other works a Book of Animals. Scientific evolution at the time of the Abbasides; Life of AL JAHIZ; Arabic knowledge of nature. The contents and characteristics of the Book of Animals are given. G. S.

Wiedemann, Eilhard. Über Apotheker und Drogisten zur Zeit der Abbasiden. *Leopoldina*, Heft 56, p. 66-68, Halle a. S. 1920. 1818

Four short notes three of which deal with ZAKARIJĀ AL ṬAIFŪRĪ.
G. S.

S. X.

Schoy, Carl. Über eine arabische Methode, die geographische Breite aus der Höhe der Sonne im 1. Vertical (« Höhe ohne Azimut ») zu bestimmen. *Annalen der hydrographie und maritimen Meteorologie*, April 1921, 124-133. 1818

Translation of a fragment of the Leiden Arabic Ms. 143 by the Cairene astronomer IBN YŪNUS (d. Cairo 1009). IBN YŪNUS in his Ḥākemitic tables, — which the author considers the most important work of Arabic astronomy — gives various methods of determining latitude; he determined himself the latitude of Old Cairo with remarkable accuracy (30°). The fragment translated and explained by SCHOY contains a method of determining latitude by the observation of the height of the sun in the first vertical circle at the summer solstice. G. S.

Schoy, Carl. Abhandlung des HASAN BEN AL-HUSAIN BEN AL-HAITAM über eine Methode die Polhöhe mit grösster Genauigkeit zu bestimmen. *De Zee*, no. 10, jaargang 1920, bdz. 586-601. 1818

This important work of ALHAZEN is translated from a Leyden ms. (catal. cod. orient., III, 94), with prefatory explanation. G. S.

Schoy, Carl. Abhandlung des AL-HASAN IBN AL-HASAN IBN AL-HAITAM (ALHAZEN) über die Bestimmung der Richtung der Qibla. *Zeitschrift der deutschen morgenländischen Gesellschaft*, t. 75, 242-253, Leipzig 1921. 1818

Translated from the Oxford ms. Selden Arch A. 34 (= 877, 4° of Catal. cod. orient. bibl. Bodleyana, Oxon, 1787); with a prefatory note explaining the importance of the determination of the *Qibla* (that is, the direction of Mecca). ALHAZEN'S memoir is purely mathematical (not astronomical) and the trigonometrical problem involved is solved in a purely geometrical manner. G. S.

Wiberg, Jul. The anatomy of the brain in the works of GALEN and 'ALI 'ABBAS, a comparative historical-anatomical study. *Janus*, t. 19, p. 17-32, 84-104. Leyde 1914. 1818

This study is based upon the original Greek and Arabic texts of which the author gives us a complete translation followed by a comparison (p. 92-104). The expenses of the translation were defrayed by the « January-Society », the aim of which is to develop intellectual intercourse between Denmark and the countries of W. Europe. G. S.

S. XI.

Eckleben, Willy. Die abendländischen AVICENNA-KOMMENTARE. (*Diss.*, Leipzig). 23 p. Leipzig 1921. 1818

A list of Western commentaries on the *Canon*, book by book and fen by fen, the editions of each being quoted. There is also a short list of com-

mentaries on other works of AVICENNA. Eastern commentators (of whom there are about 30) are not mentioned. G. S.

Suter, H. und **Wiedemann, E.** (unter Mitwirkung von O. RESCHER). Ueber AL BÎRÛNÎ und seine Schriften. (Beiträge zur Gesch. d. Naturw., 60). *Sitzungsber. d. physik. mediz. Sozietät*, Erlangen, Bd. 52-53, 1920-1921, p. 55-96. 1918

An elaborate account of the life and works of MUḤ. B. AḤMED ABÛ RAIḤÂN (or ABU'L RAIḤÂN) AL BÎRÛNÎ, born in Sept. 973 in a suburb of Chwârizm (Chiwa) of Iranian stock, died at the end of 1048 in Gazna, Afghanistan. G. S.

Wiedemann, Eilhard. Über die Wage des Wechselns von AL-CHÂZINÎ und über die Lehre von den Proportionen nach AL BÎRÛNÎ.. (Beiträge zur Gesch. d. Naturwiss., 48). *Sitzungsber. d. physik.-medizin. Sozietät*, t. 48-49, 1-15, Erlangen 1918. 1918

Translation of the part of AL BÎRÛNÎ's *Kitâb al Tafhîm* (Book of Instruction) dealing with the theory of proportion and of a part af AL CHÂZINÎ's Balance of Wisdom completing the former extract. [AL CHÂZINÎ wrote the Balance of Wisdom tables about 515 = 1121-1122]. G. S.

Wiedemann, Eilhard. Magnetische Wirkung nach der Anschauung der Araber. *Zeitschrift für Physik*, 1920, 141-142. 1918

A propos of a passage of the physician and philosopher IBN BUTLÂN in which the problem is raised whether the attraction of a piece of iron by a magnet is a love attraction or not. G. S.

Wiedemann, Eilhard. Über Gesetzmässigkeiten bei Pflanzen nach AL BÎRÛNÎ. *Biolog. Zentralblatt.*, t. 40, 113-116, 1920. 1918

Very wise rebuke of Christian superstitious ideas, for instance about the shape of a cross in the wood of Paeonia. Also remarks on the symmetry of flowers. G. S.

Zervos, Ch., Un philosophe néoplatonicien du XI^e^ siècle, MICHEL PSELLOS. Sa vie, son œuvre, ses luttes philosophiques, son influence (*Thèse*) VII + 259 p. Paris, LEROUX, 1919. 1918

S. XII.

Conybeare, F.-C. Four Armenian tracts on the structure of the human body. *Studies in the history of science*, vol. II, 359-384. Oxford, 1921. 1918

From the British Museum Codex Or. 6798; these 4 treatises represent the medical learning of the Armenians not later than the twelfth century. The texts are fully translated. G. S.

Kroner (Rabbiner, Dr.). Eine medizinische MAIMONIDES Handschrift aus Granada. Ein Beitrag zur Stilistik des MAIMONIDES und zur Charakteristik der hebräischen Uebersetzungsliteratur. Im Urtext hrg., übersetzt u. kritisch erl. *Janus*, t. 21, 203-247. Leyde 1916. 1918

[Nicolaus Praepositus]. W.-S. VAN DEN BERG. Eene middelnederlandsche vertaling van het *Antidotarium* NICOLAÏ. Met den

latijnschen tekst der eerste gedrukte uitgave van het *Antidotarium* NICOLAÏ. Leyde, *Brill*, 1917. 1818

I know this publication only through a review by M.-A. VAN ANDEL in *Janus*, t. 22, 271-273. The Dutch text (MS. 15624-15641, Bibl. royale, Bruxelles) dates of 1351. Compare with the two French translations of the XIVth and XVth cent. published by PAUL DORVEAUX, Paris, 1896. G. S.

Porter, A. Kingsley. La sculpture du XII^e^ siècle en Bourgogne. *Gazette des Beaux-Arts*, Paris 1921, 22 p. illustrées. 1818

L'auteur discute les deux systèmes contradictoires sur lesquels est fondée la chronologie de l'art roman : l'un, formulé par les archéologues français, est basé sur les monuments; l'autre, qui se fonde sur les documents, est né en Italie et en Espagne. L'auteur défend le dernier système: « L'Art du Moyen Age ne nous a rien laissé de plus beau que la sculpture bourguignonne. » G. S.

Roth, F.-W.-E. Studien zur Lebensbeschreibung der heiligen HILDEGARD (1098-1179). *Studien und Mitteilungen zur Geschichte des Benediktinerordens und seiner Zweige*, Bd. 39, 88-118, Salzburg 1918. 1818

Critical study of the sources and known facts. Important. G. S.

Wiedemann, Eilhard Über die angebliche Beobachtung eines Planetendurchganges durch AVERROES und andre. *Das Weltall*, J. 20, 180-181, 1920. 1818

S. XIII.

Enestrŏm, Gustav. Sur l'auteur d'un traité *de motu* auquel BRADWARDIN a fait allusion en 1328. *Archivio di storia della scienza*, vol. 11, 133-136, Roma 1921. 1818

Il s'agit du traité dont parle DUHEM dans ses Études sur LÉONARD, 3^e^ série, p. 292-294. D'après d'autres MSS. étudiés par ENESTRŎM, l'auteur en serait un « Magister GERARDUS de Brussel » (serait-il identique à RICARDUS de Usellis?). ENESTRŎM le place au XIII^e^ siècle. G. S.

Haskins, Charles-H. The *de arte venandi cum avibus* of the emperor FREDERICK II. *English Historical Review*, July 1921, 334-355. 1818

It is very strange that the main literary work of FREDERICK II has not yet been completely edited. Of the six books, only the first two have been edited : ed. princeps of VELSER, Augsburg, 1596, reprinted with a valuable zoological commentary by J.-C. SCHNEIDER, Leipzig 1788-1789; a poor ed. of a mutilated text. HASKINS' memoir is the first based upon a study of the complete text. It contains a description and criticism of the MSS., divided into two families: a two-book family with additions by King MANFRED and remarkable illustrations and a six-book family without these additions but in which the *lacunae* in books I and II are filled. The Vatican codex (a XIIIth cent. MS. of the first family) contains more than 900 figures of individual birds admirably done from life. Then HASKINS analyzes the whole work (that FREDERICK himself was the author can no longer be doubted; it was composed c. 1244-1250, probably on or after 1248) and studies its sources. These were of three kinds : systematic treatises on natural history, notably ARISTOTLE; practical treatises on

falconry and the direct observation and personal enquiries of the author. « The first book and earlier chapters of the second have a systematic and a scientific character which give them an important place in the history of mediæval zoology, while the whole treatise is pervaded by the spirit of actual observation and experiment. » May HASKINS' elaborate study hasten the edition of this very important work! G. S.

Henricus Dacus (Henrik Harpestreng). De simplicibus medicinis laxativis. Publié par J.-W.-S. JOHNSSON. *Janus*, t. 22, 27-55, 61-114, 2 pl., Leyde 1917. ISIS

With commentary, notes and comparison between the Latin DACUS text and the Danish HARPESTRENG text which are shown to be entirely equivalent. This publication is a translation of the Danish edition of 1914 (*Isis*, IV, 13). G. S.

Jäger, Fritz. Zahnärztliches aus den Werken ALBERTS DES GROSSEN und seiner Schüler THOMAS VON CANTIMPRÉ und VINCENZ VON BEAUVAIS (*Diss.*, Institut f. Gesch. d. Medizin, Leipzig), 63 p. Mannheim 1921. ISIS

Manly, John-M. The most mysterious manuscript in the world. Did ROGER BACON write it and has the key been found? HARPER'S Magazine, vol. 143, p. 186-197, 5 illustrations. New York, July 1921. ISIS

A propos of the MS. brought to light by WILFRED M. VOYNICH, the bookseller, in 1912 and of which Prof. WILLIAM ROMAINE NEWBOLT of the University of Pennsylvania claims to have discovered the secret. This MS. is ascribed to ROGER BACON. It is a small volume (8 1/2 × 5 3/4 in.) on vellum, containing originally 272 p. (26 p. have been lost), illustrated with coloured drawings (« plants, leaves and roots, astrological diagrams, realistic and symbolical representations of cell development, strange pictures of nude women »), written in cipher. A letter is attached to it, written by JOH. MARCUS MARCI in 1665 when he presented it to ATHANASIUS KIRCHER. Apparently the MS. once belonged to the Emperor RUDOLF and was believed by members of the court circle to be ROGER BACON'S work. It is possible that RUDOLF had received it from JOHN DEE. The MS. is apparently a medical treatise, but then why such secrecy? Prof. NEWBOLT explained the cipher before the College of Physicians of Philadelphia and the American Philosophical Society in April. He has already deciphered in it astronomical observations and predictions, scientific theories, historical facts (*ex. gr.* the account of a riot in Oxford on Feb. 27, 1273). The MS. would prove that BACON used a telescope and a simple microscope, and the discovery of many biological and embryological facts could be ascribed to him (seminiferous tubes, cells with nuclei, spermatozoa!). This has been studied by Prof. MCCLUNG, the histologist. According to some other enthusiast, the drawings suggest the use of a compound microscope (magnification, 75!) — NEWBOLT'S system of decipherment is so flexible that it is untrustworthy, for « absolute certainty of interpretation is one of the first essentials of a good cipher ». MANLY discusses NEWBOLT'S system and is rather sceptical about it. I share fully his scepticism. G. S.

Steele, Robert. ROGER BACON and the state of science in the thirteenth century. *Studies in the history and method of science*, vol. 2, 121-150, Oxford 1921. ISIS

A general study of BACON'S work with special reference to his environment. « ROGER BACON stands out prominently as the first English leader

of scientific thought... In his works we can trace the process of emancipation from established ruts of thought and the entrance of new conceptions. We can follow his attempts to make a theory explain the whole body of natural phenomena, the gradual elaboration of a mathematical theory of action at a distance, which, unfruitful at the moment, reappears in a fuller form in modern science. We see him as a pioneer of textual criticism, a critic of established authorities... The work of such a one should be available to all the world of scholars : more than half of it in bulk is still locked up in single MSS. difficultly legible and almost inaccessible »..

G S.

Thomas, Antoine. Jean Pitart, chirurgien et poète. *Janus*, t. 22, 279-293. Leyde 1917. 1818

Thomas, Antoine. Jean Pitart, chirurgien et poète. *Comptes rendus de l'Académie des inscriptions*, Paris 1916, p. 95-111. 1818

Sa vie ; ses écrits : 1. Le recueil de recettes médicales qui lui est attribué est l'œuvre d'un compilateur postérieur ; 2. Le *Dit de Bigamie*. — Pitart est le premier chirurgien français qui ait jeté de l'éclat sur sa profession, mais sa renommée est appuyée sur bien peu de chose. Il n'est aucunement prouvé qu'il ait vraiment fondé le Collège de Chirurgie de Paris en 1271, ni que Lanfranc y ait été reçu en 1295. Le premier document authentique relatif à Pitart date de 1292 ; il n'est pas mort en 1315, mais au plus tôt en 1327 ou 1328. G. S.

Wickersheimer, Ernest. Les origines de la faculté de médecine de Paris ; sa situation dans l'université naissante. *Bull. Soc. franç. hist. méd.*, t. 13, 249-260. Paris 1914. 1818

« Si l'on fait abstraction des témoignages de Gilles de Paris et de Guillaume le Breton, c'est dans un mandement épiscopal daté de 1213 qu'il faut chercher la trace la plus ancienne d'un enseignement médical dans l'université de Paris »... G. S.

Wickersheimer, Ernest. Maître Henri de Danemark, médecin à Orléans sous le règne de Philippe-Auguste. *Bull. Soc. franç. hist. méd.*, t. 14, 243-245, Paris 1920. 1818

Il s'agit sans doute du même personnage que Henricus Dacus, alias Henrik Harpestreng, étudié par J.-W -S. Johnsson (*Isis*, IV, 13).

Wiedemann, Eilhard. Über die Kriechtiere nach al Qazwînî nebst einigen Bemerkungen über die zoologischen Kenntnisse der Araber. (Beitr. zur Gesch. d. Naturw., 53). *Sitzungsber. d. physik. mediz. Ges.*, t. 48, 228-285, Erlangen 1918. 1818

See below under Islam, p. 431. G. S.

Wiedemann, Eilhard. Übersetzung und Besprechung des Abschnittes über die Pflanzen von Qazwînî (Beitr. zur Gesch. d. Naturwiss., 54). *Sitzungsber. d. physik. mediz. Gesellschaft*, t. 48, 286-321. Erlangen 1918. 1818

Translation with commentary of the text published by Wüstenfeld, Bd. 1, 245-301. G. S.

Wiedemann, E. und **Hauser, F.** Über eine Palasttüre und Schlösser nach al Gazarî. *Der Islam*, t. 11, 213-251, 1921. 1818

This study is based on a part of the last domain (nau') of Gazarî's work

on the knowledge of geometrical, ingenious (mechanical) contrivances, composed in 1205-1206. WIEDEMANN and his friends have now placed this whole work within the reach of non-Arabic scholars (a list of their previous studies will be found on p. 214). See *ex. gr.*, *Isis*, III, 324, 478.
G. S.

Wiedemann, Eilhard. Beschreibung von Schlangen bei IBN QAFF. (Beitr. zur Gesch. d. Naturw., 50). *Sitzungsber. d physik. medizin. Sozietät*, t. 48-49, p. 61-64, Erlangen 1918. 1918

Translation with commentary of the chapter on snakes in the *Gâmi' al Garad fi Hifz al Sihha wa Daf' al Marad* (Compendium of what one should know to preserve one's health and avoid disease) by ABU'L FARAG IBN JA'QÛB, usually named IBN QAFF (or IBN al QUFF) al MASÎHÎ (the Christian), who died in 685=1286. G. S.

S. XIV.

Battistini, Mario. Note d'archivio. *Archivio di storia della scienza.* Vol. 2, 211-214, Roma 1921. 1918

1. Un medico del carcere di Firenze nel sec. XIV (ANDREA DI BARTOLO); 2. Maestro GREGORIO DA PISA, oculista del sec. XIV, condotto a Firenze; 3. Maestro BELTRAMO DA CORTONA, medico occulista a Firenze nel sec. XIV; 4. La condanna e la grazia di Maestro STEFANO DEGL' IMPIASTRI nel 1341; 5. Maestro CRISTOFANO DEI BRANDAGLINI di Firenze (fl. at the end of S. XIV). G. S.

[Hâfiz]. Selections from the Rubaiyât and Odes of HÂFIZ. Collected from many old Persian manuscripts and rendered into English verse by a member of the Persia society of London. Together with an account of Sûfi mysticism. 147 p. London, WATKINS, 1920. 1918

Krause, F.-C.-A. Das Mongolenreich nach der Darstellung des Armeniers HAITHON. HIRTHS Festschrift, Berlin 1920, 238-267. 1918

A propos of HAITHONI ARMENI *historia orientalis : quae eadem et de Tartaris inscribitur*, that is, the relation dictated by HAITHON the younger to Brother NIC. SALCONI in French, and translated by the latter into Latin by order of Pope CLEMENT V, A. D. 1307. G. S.

Loria, Gino. DANTE (1) e la scienza del suo tempo. *Conferenze e Prolusioni*, anno XIV, 193-202. Torino 1921. 1918

A lecture delivered at the University of Genoa in April 1921 and divided as follows : scientific character of the *Commedia ;* the importance of number in this poem; DANTE'S mathematical knowledge; DANTE as a naturalist; his travels ; his astronomical knowledge; astrology; DANTE and modern science. G. S.

Passerini, Giuseppe Lando (*editor*). Le vite di DANTE, scritte da GIOVANNI e FILIPPO VILLANI, da GIOVANNI BOCCACCIO, LEONARDO ARETINO e GIANNOZZO MANETTI, ora novalmente publicate con introduzione e con note. XLVIII + 292 p. Firenze, SANSONI, 1917. 1918

(1) Henceforth, I will put the DANTE literature under S. XIV (instead of S. XIII as I did before), because DANTE'S works were accomplished in the beginning of the XIVth century. (*Isis*, IV, 137). G.S.

Sagher, De. Note concernant l'année de la mort de JAN YPERMAN. *Janus*, t. 19, 33-34, Leyde 1914. 1818

From documents in the archives of Ypres (now presumably destroyed), it would appear that YPERMAN died between Oct. 28, 1330 and Nov. 1, 1331. G. S.

Scheffer, Hans. Ein therapeutischer *Thesaurus pauperum* des 14. Jahrhunderts in lateinischen Versen nach einer Leipziger und zwei Münchener Handschriften. (*Diss.*, Leipzig; Institut f. Gesch. d. Medizin). 31 p. Leipzig 1921. 1818

The best known medical compilation of the Middle Ages is the *Regimen Sanitatis Salernitanum* dating of the beginning of the XIVth century. There are many other poems of the same time more or less different from the Salernitan collection (see SUDHOFF, *Archiv. f. Gesch. d. med.*, XII, 149) and the *Thesaurus pauperum* is one of them. It is here edited on the basis of three MSS., of which the oldest (Monacensis 251) dates of the second half of the XIVth cent. and contains 500 verses. — The text is followed by a short commentary and an index of the drugs mentioned. G. S.

Toynbee, Paget. Britain's tribute to DANTE in literature and art. A chronological record of 540 years (c. 1380-1920). The British Academy (DANTE commemoration 1921). XVI + 212 p. London, Milford 1921. 1818

A chronological bibliography with two indexes : I. Literature; II. Art. This is not a critical bibliography, for there are but few critical notes; yet it may prove useful. G. S.

Wiedemann, Eilhard. Über den Abschnitt über die Pflanzen bei NUWAIRI. (Beitr. zur Gesch. d. Naturw., 51). *Sitzungsber. d. physik. medizin. Gesell.*, t. 48, 151-176, Erlangen 1918. 1818

Transl. from the part of AL NUWAIRI's great encyclopædia dealing with plants, with commentary. For a translation of the part dealing with drugs, see below under Islam (p. 431). G. S.

S. XV.

[Amirdolvathe d'Amassie]. Tini-Maghtum traduit du texte arménien de l'ouvrage D'AMIRDOLVATHE (D'AMASSIE), médecin arménien du XV^e^ siècle, par VAHRAM H. TORKOMIAN. *Janus*, t. 20, 109-112, Leyde 1915. 1818

Tini-maghtoum (ou dini-mahtoum); en arménien, matnéhar-gav; en persan, guili-maghdoum; en italien, terra sigillata. G. S.

Seybolt, Robert Francis. The *Manuale Scholarium*. An original account of life in the mediæval university. 122 p. Cambridge. Harvard University Press, 1921 [$ 1.50]. 1818

The *Manuale*, the author of which is unknown, first appeared in 1481, and was frequently re-edited in the XVIth and XVIIth centuries. It is our chief source of information on student life in the XVth century in German universities, more particularly Heidelberg, and has been used extensively by all writers on mediæval education. It consists of a series of dialogues between two students on the main topics of interest to them (their initiation, exercises, lectures, amusements, women, quarrels, etc.). Judging from the few passages I have been able to check, the translation

in colloquial English corresponding to the colloquial Latin, is excellent (it is the first complete translation in any modern language). The translator has added elaborate explanations in the introduction and the footnotes and a few typical statutes selected from the codes of Erfurt, Heidelberg and Leipzig, in an appendix. This translation makes excellent reading though it is not as racy as the Latin original. G. S.

Sudhoff, Karl. Nochmals Dr. Cornelis Roelants von Mechelen, der von ihm benutzte frühmittelalterliche Leitfaden für die Kinderpraxis und ein pseudo-Galenus *de passionibus puerorum* aus der Spätantike. *Janus*, t. 20, 443-458, Leyde 1915. 1818

Cornelis Roelants, graduated as M. D., Louvain 1488, a physician of renown in 1497, d. 1525. G. S.

Bilancioni, Guglielmo. A proposito de « L'orecchio e il naso nel sistema antropometrico di Leonardo da Vinci ». *Archivio di storia della scienza*, vol. 2, 250-253, Roma 1921. 1819

Discussion of Giuseppo Favaro's unfriendly criticisms of his book (see *Isis* IV, 141). G. S.

Hopstock, H. Leonardo as anatomist, translated from the Norwegian by E.-A. Fleming. *Studies in the history and method of science*, vol. 2, 151-191, with illustr. Oxford 1921. 1819

For the original memoir, see *Isis* III, 331. It is a general survey of the subject by one of the editors of the *Quaderni*. G. S.

Lorenzo, Giuseppe de. Leonardo da Vinci e la Geologia. (Pubblicazioni dell' istituto vinciano in Roma, III), 197 p. Bologna 1920. [L. 15]. 1818

This book is not on the same level as Venturi's (see below); indeed, it is disappointing. We expected to find a comprehensive and sober account of Leonardo's ideas on geology, but we are given instead the most discursive dissertation imaginable. Only 59 pages are devoted to Leonardo, and even then the author finds it difficult to stick to his subject! The rest is an amazing hotchpotch. Lorenzo's frequent references to Buddhistic literature, if not strictly relevant, are interesting. Mario Baratta's account was more modest but far more satisfactory. G S.

McMurrich, J. Playfair. Leonardo da Vinci. The artist. *Queen's Quarterly*, vol. 28, 402-418. Kingston, Queen's University, 1921. 1818

A lecture delivered before the Women's Art Association of Toronto, Jan. 1921. G. S.

Regnault, Félix. Les dessins de Léonard de Vinci. *Bull. soc. franç. hist. méd.*, t. 13, p. 478-488. Paris 1919. 1818

Leur réalisme : les édentés, représentation du syndrome oxycéphalique, etc. G. S.

Vasari, Giorgio. La vita di Leonardo da Vinci. Nuovamente commentata e illustrata con 200 tavole a cura di Giovanni Poggi. 63 p. + 200 pl. + lxxvii p. Firenze, Luigi Pampaloni, 1919. 1818

Venturi, Adolfo. Leonardo da Vinci pittore (Pubblicazioni dell' Instituto Vinciano in Roma, II), 197 p., 129 fig. Bologna 1920. [L. 35]. 1818

The first vol. of this collection, by Lionello Venturi, dealt with Leonardo's theories of art (*Isis* III, 458). The present one by the great historian of Italian art is as good as we expected, and our expectations were high. It is perhaps the best general account of Leonardo the Artist available to-day. The method of presentation is excellent : I. Notizie storiche sulle pitture di L. (61 p.); II. Le opere pittoriche di L. (65-141); III. Regesti dell'opera pittorica di L. (that is, a chronology *raisonnée*, very elaborate). The illustrations are excellent. G. S.

S. XVI.

Blok, P.-J. Rembert Dodoens, protestant? *Janus*, t. 22, 269-270. Leyde 1917. 1818

Ses sympathies étaient plutôt catholiques, mais il était « de la religion d'Erasme ». G. S.

Cumston, Charles Greene. The finances of Felix Platter, professor of medecine at Bale. *Annals of medical history*, t. II, 265-266. New York 1921. 1818

Felix Platter (b. Bâle 1536, d. 1614), professor of medicine at the Bâle university, physician (*archiater*) of the city, founder of a museum of natural history, as well as the botanical garden of the university.

G. S.

[Diez, Juan]. The *Sumario Compendioso* of Brother Juan Diez. The earliest mathematical work of the new world by David Eugene Smith. 65 p. Boston, Ginn, 1921. 1818

A facsimile reproduction of the earliest mathematical work printed in the Americas, with translation on the opposite pages and a learned introduction. The *Sumario* appeared in Mexico city in 1556 (printing began there in 1536). Juan Diez was a native of Galicia, a companion of Cortés, the editor of Juan de Avila (the apostle of Andalusia) and of the *Itinerario* of the Spanish fleet to Yucatan in 1518. His book was published chiefly to assist the buyers of gold and silver in their computations; that is, it is a book of the same class as the *Tariffa de pexi e mesure* by Ant. Bart. di Paxi, Venezia 1503 or the *Tariffa perpetua* by Giov. Mariani, *ibidem*, 1535. Of the tables only one page is reproduced, but the arithmetical and algebraical parts are reproduced *in extenso*. The six pages of algebra are especially interesting (Cardan's *Ars Magna* had appeared only in 1545) — No other mathematical book was published in Mexico in the xvith cent., except for a brief *Instrucción Nautica*, 1587. G. S.

Dodoens, Rembert (Malines, Belgium, June 29, 1517 — March 10, 1585). A whole number of *Janus*, t. 22, p. 141-204, Leyde 1917, was devoted to him to celebrate the fourth centenary of his birth. It contains an introductory editorial by E.-C. van Leersum and the following essays : F.-W.-T. Hunger. D. comme botaniste; M.-A. van Andel. D. and his influence on Flemish and Dutch folk-medicine; J.-G. De Lint. Les portraits de D. (2 illustr.); M.-J. Sirks. L'herbier flamand de D. G. S.

Dorveaux, P. La botanique dans les « Satyres chrestiennes de la cuisine papale ». *Janus*, t. 21, 149-166, Leyde 1916. 1818

Les « Satyres chrestiennes » : un pamphlet huguenot anonyme, dont la 1re éd. parut chez CONRAD BADIUS à Genève en 1560. G. S.

Favaro, Antonio. GALILEO GALILEI in una rassegna del pensiero italiano nel corso del secolo decimosesto. *Archivio di storia della scienza*, vol. II, 137-146, 1921. 1818

A learned essay suggested by : ROGER CHARBONNEL. La pensée italienne au XVIe siècle et le courant libertin. Paris 1919, with a most interesting prefatory statement on the work of P. DUHEM. G. S.

Foster, William (*editor*). Early travels in India (1583-1619). XIV + 351 p., 10 illustr. Oxford University Press, 1921. 1818

This collection of early travels reprinted from various older editions includes the reports of all the travellers of importance who visited N. and W. India under the reigns of AKBAR and JAHANGÎR, except Sir THOMAS ROE. That is : RALPH FITCH, 1583-1591 ; JOHN MILDENHALL, 1599-1606 ; WILLIAM HAWKINS, 1608-1613 ; WILLIAM FINCH, 1608-1611 ; NICHOLAS WITHINGTON, 1612-1616 ; THOMAS CORYAT, 1612-1617 ; EDWARD TERRY, 1616-1619. The editor of this collection is already well known because of his great work on the English factories in India, a calendar of documents from 1618 to 1660, 10 vol., 1906-1921. G. S.

Hellweg, Heinrich. Die Lehre des BARTOLOMEO EUSTACHI über Bau und Entwicklung der Zähne (*Diss*, Institut für Gesch. d. Medizin). 38 p. Leipzig 1921. 1818

Hemmeter, John C. MICHAEL SERVETUS (1511-1553). Discoverer of the pulmonary circulation. His life and work. *Janus*, t. 20, 331-364, 9 pl. Leyde 1915. 1818

Includes a bibliography and 9 valuable illustrations (title pages, monuments, portrait) loaned by Sir WILL. OSLER. G. S.

Holl, Moriz und **Sudhoff, Karl.** Des ANDREAS VESALIUS sechs anatomische Tafeln vom Jahre 1538 in Lichtdruck neu herausgegeben. Folio, 12 p., 6 fascimile pl. Leipzig, BARTH, 1920. 1818

A splendid facsimile reproduction of the little school-atlas published by VESALIUS in Venice 1538, that is, five years before the *Fabrica*. VESALIUS received the assistance of JAN STEPHAN VAN CALCAR, who probably drew the skeleton of the last 3 plates. This atlas was published by VESALIUS during the first year of his teaching in Padova ; it was used so extensively that only two copies of it are known to exist : one in San Marco, Venice ; the other in WILLIAM STIRLING-MAXWELL'S collection. The latter published a facsimile ed. of his copy in 1874. The present edition is a facsimile of the San Marco copy ; 3/4 of the original size. It is preceded by a historical introduction by SUDHOFF, and an elaborate description of each plate by the late M. HOLL (1852-). G. S.

Leclerc, Henri. L'art d'obtenir des fruits laxatifs d'après ANTOINE MICHAUD. *Bull. soc. hist. méd.*, t. 15, 121-124. Paris 1921. 1818

A propos de l'*Alexikepus* d'ANTONIUS MISALDUS, traduit en français par ANTOINE CAILLE, 1578 ; exposé d'une méthode pour donner des propriétés médicamenteuses à des fruits par injection dans la plante vivante ou par greffe. G. S.

Montgomery, Douglas W. The quintessence in RABELAIS. *Annals of medical history*, II, 330-333, New-York 1919. 1818

Paoli, Humberto Julio. Il libro di GARCIA DA ORTA. Contributo alla storia della scienza lusitana. *Archivio di storia della scienza*, vol. II, 202-210, Roma 1921. 1818

Important bibliographical study of GARCIA DA ORTA'S famous book, *Coloquios dos simples e drogas he cousas medicinais da India...* Goa, 1563, which has been studied in *Isis* (II, 415) apropos of Sir CLEMENTS MARKHAM'S translation. G. S.

Rosenbloom, Jacob. Statements of medical interest from the life of BENVENUTO CELLINI (1500-1571). *Annals of medical history*, II, 348-366. New York 1919. 1818

Ruhräh, John. THOMAS PHAER. *Annals of medical history*, II, 334-347. New York 1919. 1818

THOMAS PHAER (1510?-1560), physician, the father of English pediatrics, the author of *The Booke of Chyldren*, translator of the *Aeneid*, 1584. G. S.

Scheienz, Hermann. Geheimlehren. Dämonologie bei SHAKESPEARE. *Janus*, t. 20, 155-173. Leyde 1915; t. 21, 1-26, 1916; t. 22, 1-26, 239-268. 1818

[Vésale, André]. A whole number of *Janus*, t. 19, p. 397-523, Leyden 1914, was devoted to him apropos of the fourth centenary of his birth. It contains an introductory article by E.-C. VAN LEERSUM and the following memoirs : J.-G. DE LINT. Les portraits de V.; L. KNAPPERT. L'église et la science au temps de V.; F.-M.-G. DE FEYFER. Die Schriften des V. (this is the most important contribution, p. 435-507, an elaborate bibliography of V. 's writings, including the apocryphal, with an iconographical study and a separate index); J. BOEKE. V. comme réformateur de l'anatomie; J.-J. VAN DER KLEIJ. Von wo stammen die Vorfahren von V. her? G. S.

Wagner, Hermann. Die Legende der Längenbestimmung AMERIGO VESPUCCI'S nach Mondabständen (23. Aug. 1499). *Nachrichten d. Kgl. Ges. d. Wiss., math. physik. Klasse*, J. 1917, 264-298. 1818

VESPUCCI is not the inventor of the determination of longitudes by means of lunar distances, for the letter upon which this claim rested is apocryphal. This method was unknown in the XVth century. G. S.

Wickersheimer, Ernest. Une gravure anatomique de JOBST DE NECKER (1538). *Bull. soc. hist. méd.*, t. 15, 114-118, Paris 1921. 1818

S. XVII.

Bachmann, Paul. Das FERMAT-problem in seiner bisherigen Entwicklung. VIII + 160 p., Berlin, Vereinigung wissensch. Verleger, 1919. 1818

[Bartholinus, Thomas. 1616-1680]. A whole number of *Janus*, t. 21, p. 271 to 378, Leyde 1916 was devoted to him to celebrate the tercentenary of his birth. It contains a general study by V. MAAR

and the following : B. and archæological researches in Denmark in the XVIIth cent. by C. NEERGAARD; Quelques lettres de B. à OLAUS WORM, éditées par J.-W.-S. JOHNSSON; Sur les portraits de B. par O. ANDRUP (p. 324-338; plusieurs portraits sont reproduits); The *domus anatomica* at the time of B. by V. MAAR; A memorial tablet lost and found by same; A few remarks about B. 's life in the country by A. GARBOE (with views of the manor Hagested or Hagestedgaar, where B. settled in 1660, which was destroyed by fire in 1676 — with B. 's library —, which he rebuilt and where he died in 1680); Les nobles B. par A. THISET; The B. family by K. CARÖE; La famille des B. par C.-T. BARTHOLIN (there are few descendants of B. in Denmark, but many more in Chili); Quatre lettres de B. par P.-C. MOLHUYSEN. G. S.

Bigourdan, G. Sur diverses stations astronomiques françaises du XVII^e^ siècle. *Comptes rendus de l'Académie des sciences*, t. 166, p. 269-275. Paris 1918. 1818

Other notes on French astronomy in the XVIIth cent. and later will be found in the *Comptes-rendus*, passim. I do not quote them individually for they are merely of local interest and will be, I understand, reprinted in book form. G. S.

Boulenger, Jacques. The seventeenth century. London, HEINEMANN; New-York, PUTNAM, 1920. 1818

Translation of « Le grand siècle », published by HACHETTE in 1911. G. S.

Castiglioni, Arturo. La vita e l'opera di SANTORIO SANTORIO CAPODISTRIANO (1561-1636). 86 p., illustr. Bologna, L. CAPPELLI, 1920. [L. 5]. 1818

A short biography, but complete, well-informed, well thought out and agreeably written. An up-to-date bibliography makes it easy to find whatever additional information may be needed. SANTORIO's work was of the greatest importance and well might BOERHAAVE say of his *de statica medicina* (1614) : « Nullus liber in re medica ad eam perfectionem scriptus est ». The author analyzes briefly the *statica* and also the minor writings and discusses the introduction of clinical instruments by SANTORIO. An excellent little book. G. S.

Daniels, C.-E. Beiträge zur Geschichte der Geburtshilfe. III. *Janus*, t. 21, 167-181, portrait, Leyde 1916. 1818

Devoted to the Swedish obstetrician JOHAN VAN HOORN, born of Dutch parentage in Stockholm 1631, author of « Then swenska walöfwada jordegumman » (the well-trained Swedish midwife) 1697, died Stockholm 1724. — For other studies by DANIELS, see under S. XVIII. G. S.

Del Lungo, Carlo. Del pendolo e della sua applicazione all'orologio. *Archivio di storia della scienza*, vol. II, 147-166, Roma 1921. 1818

A careful study of the discovery of the pendulum, of the law of isochronism of the small oscillations, of the relation between the length of the pendulum and its period and of its first application to clockmaking, — chiefly to vindicate GALILEO against the malicious attacks of CAVERNI (see *Isis* III, 493). G. S.

Fahie, J.-J. The scientific works of GALILEO (1564-1642) with some account of his life and trial. Being a review of Favaro's Edizione nazionale delle Opere di GALILEO (1890-1909). *Studies in the history and method of science*, vol. II, 206-284, illustr. Oxford 1921.
1818

Goulard, Roger. A propos de l'affaire des poisons ; Le célèbre édit de 1682 *Bull. soc. franç. hist. méd.*, t. 13, 260-268. Paris 1914.
1818

Graeven, Hans (1866-1905). LEIBNIZENS Bildnisse. Vervollständigt und hrg. v. CARL SCHUCHHARDT. Mit 24 Tafeln. *Abhdl. d. kgl. preus. Akad. d. Wiss , philosophisch-histor. Klasse*, J. 1916, Nr 3. 80 p. Berlin 1916. 1818

Die Aufdeckung der Gebeine von L.; die Überlieferung über die Bildnisse; die erhaltenen Oelgemälde; die Kupferstiche; die Büsten; Ergebnis; beschreibendes Verzeichnis der sämtlichen Bildnisse — 56 different portraits are reproduced. G. S.

Hervey, Mary F.-S. (1853-1920). The life, correspondence and collections of THOMAS HOWARD, earl of ARUNDEL. [1585-1646] XXXII + 652 p., Cambridge University Press, 1921. 1818

Lang, Robert. JOHANN CONRAD PEYER, *Janus*, t. 19, p. 61-83, Leyde 1914. 1818

Physician of Schaffhausen, b. 1653—d. 1712, described the follicles of the intestine. G. S.

Leclerc, Henri. La liqueur anti-varioleuse de WALDSCHMIDT et DOLOEUS. *Bull. soc. franç. hist. médec.* t. 14, 239-245, Paris 1920. 1818

Il s'agit de la *liquor contra variolas* ou *antivariolosus* inventée par le médecin allemand WALDSCHMIDT et dont il parle dans ses lettres à JEAN DOLOEUS en 1687. Il semblerait que ce remède secret était simplement du thé... G. S.

Leclerc, Henri. Un remède de GUY PATIN : le sirop de roses pales. *Bull. soc. hist. méd.*, t. 15, 212-216, Paris 1921. 1818

Leersum, E.-C. van. Trois lettres de JEAN CONRAD PEYER. *Janus*, t. 21, 111-128, 1 pl. Leyde 1916. 1818

Trois lettres de J.-C. PEYER (Schaffhausen 1653-1712) à son compatriote suisse JEAN-JACQUES WEMPFER dont les archives et la bibliothèque furent acquises par la Faculté de médecine de Leyde vers la fin du XVIII^e^ siècle. Ces lettres sont datées de Genève 1677, Paris 1677-1678 et traitent des questions d'anatomie. G. S.

[Leibniz]. Neun Briefe von LEIBNIZ an FRIEDRICH AUGUST HACKMAN, von PAUL RITTER. *Sitzungsber. d. kgl. preuss. Akad. d. Wiss.*, J. 1915, p. 714-730. Berlin 1915. 1818

Loghem, J.-J. van. The plague of the XVIIth century compared with the plague of our days. *Janus*, t. 23, 95-107. Leyde 1918.
1818

Lundsgaard, K.-K. K. BORRI, THOMAS BARTHOLIN, HENRIK SKRIVER. *Janus*, t. 23, 41-47, Leyde 1918. 1818

Apropos of the experiment shown by BORRI to OLE BORCH in Amsterdam

before 1667 : Borri cut through the cornea of an animal, pressed all the humors out of the eye, and instilled a fluid invented by himself, after which the eye refilled itself and the animal was able to see. G. S.

Moutier, François et Villaret, Maurice. A propos des atlas anatomiques à planches superposées. *Bull. soc. hist. méd.*, t. 15, 119-121, Paris 1921. 1918

Il s'agit des trois atlas suivants : Jean Remmelin, Augsbourg 1619; Michel Spacher, Amsterdam 1634 (Spacher était un collaborateur de Remmelin); J. Remmelin, Francfort 1660. G. S.

Peachey, G.-C. The two John Peacheys, seventeenth century physicians, their lives and times. *Janus*, t. 23, 121-158, Leyde 1918. 1918

John Pechey, M.-A. Oxon., Licentiate of the College of Physicians (1654-1718); John Peachie, M.-D. Caen, *extra-urbem* licentiate of the College of Physicians (? 1632-1692). Very elaborate biographies. G. S.

Rambaud, Pierre. La bibliothèque d'un médecin de Poitiers au XVII[e] siècle. *Bull. soc. franç. hist. méd.*, t. 14, 98-102. Paris 1920. 1918

Roy, Pierre Georges. Un hydrographe du roi à Québec. Jean-Baptiste-Louis Franquelin. Mémoires et comptes rendus de la Société royale du Canada, t. 13, section I, p. 47-59, 1920. 1918

Le dit Franquelin naquit entre 1651 et 1653 à Saint-Michel de Villebernin, près Bourges, il vécut dans la Nouvelle France et mourut en France entre 1712 et 1730. L'auteur énumère les vingt cartes américaines levées par lui; elles sont datées de 1678 à 1708. G. S.

Ruhräh, John. Walter Harris, a seventeenth century pediatrist. *Annals of medical history*, t. II, 228-240, New York 1919. 1918

Harris was born in 1647 (not 1651) at Gloucester, England. « Harris was not a great physician, not a master mind, not an original thinker, but he wrote a good book that held its place a hundred years; he was a shrewd and honest practitioner; a keen observer, particularly of the action of drugs, which led him to teach simplicity, caution and common sense ». The « good book » is his *de morbis acutis infantum*, Amsterdam 1689, of which many extracts are quoted. G. S.

Slaby, A. Otto von Guericke. Fest-Vortrag aus Anlass der Grundsteinlegung des Deutschen Museums gehalten im Wittelsbacher-Palais in München am 13. Nov. 1906. Deutsches Museum, *Vorträge und Berichte*, Heft 3, 13 p., 2 pl. 1918

With Guericke's portrait painted by Claus Meyer and a reproduction of his original airpump given by the University of Berlin to the Museum. G. S.

Stefanini Giuseppe. Spigolature Cestoniane. *Archivio di storia della scienza*, vol. II, 215-221, Roma 1921. 1918

Notes completing the biography of the naturalist Diacinto Cestoni (1637-1718) published by the author in *Gli scienziati italiani*, I, 122-127.

Stieda, Wilhelm. Professor Friedrich Leubnitz, der Vater des Philosophen. *Berichte d. Sächs. Ges. d. Wiss., phil. Kl.*, 69 Bd., 35 p., 3 pl., 3 facsim. Leipzig 1917. 1918

An elaborate notice on Friedrich Leubnitz (*sic*), Altenberg 1597. Leipzig

1652, the father of the great LEIBNIZ. He was professor of morals at the University of Leipzig. Three portraits; documents. G. S.

Tandberg, J.-G. Die Triewaldsche Sammlung am physikal. Institut der Universität zu Lund und die original Luftpumpe GUERICKES. *Lunds Universitets Arsskrift. Avd. 2.* Bd. 16, 4°, 31 p., Lund 1920.

1818

MARTEN TRIEWALD (1691-) after a ten years' residence in England returned in 1726 to Sweden with a rich collection of scientific instruments. In 1732, TRIEWALD'S collection was presented to the Lund Akademie by TRIEWALD'S former assistant, DANIEL MENLÖS. The catalogue of 1732 here reproduced (in Swedish) contained 327 items, of which only a few remain; among them happily one of GUERICKE'S original air pumps. TANDBERG provides a careful description of this pump and a history of other Guerickian pumps. G. S.

Villaret, Maurice et Moutier, François. La paracentèse abdominale au XVII[e] siècle. *Bull. soc. franç. hist. méd.*, t. 14, 173-178. Paris 1920.

1818

S. XVIII.

Amodeo, Federigo. Un' applicazione del teorema di NICOLA DE MARTINO sulle volte a padiglione. *Bollettino di matematica*, anno XVII, 2 p. Bologna 1921. 1818

A propos of a mathematical theorem included in N. DE MARTINO. *Elementi di Geometria...* 3 vol., Napoli 1768, vol. II, 196. G. S.

Avalon J. Une diatribe de RESTIF DE LA BRETONNE (1734-1806) contre les médecins. *Bull. soc. hist. méd.*, t. 15, 169-181. Paris 1921.

1818

Publiée en 1774 dans les « Nouveaux mémoires d'un homme de qualité », pour défendre son ami le D[r] GUILBERT DE PRÉVAL, l'inventeur d'un spécifique infaillible contre la syphilis. G. S.

Boerhaave Herman. (Voorhout, nr. Leyde 1668, Dec. 31 — Leyde, 1738, Sept. 23). A whole number of *Janus*, t. 23, p. 193 to 369, Leyde 1918, has been dedicated to him because of the 250th anniversary of his birth. After an editorial introduction by E.-C. VAN LEERSUM follow : W.-P.-C. ZEEMAN. B. et l'oculistique; MAX NEUBURGER. B.'s Einfluss auf die Entwicklung der Medizin in Oesterreich; ERNST COHEN. B. und seine Bedeutung für die Chemie (p. 223-290); J.-E. KROON. B as Professor-Promotor; E.-C VAN LEERSUM. Cours de B. en particulier ses leçons cliniques. Description de l'héritage sténographique laissé par GERARD VAN SWIETEN (plusieurs facsim.); F.-W.-T HUNGER. B. comme naturaliste; J.-G DE LINT. Les portraits en gravure de B.; W. MARTIN. Das Bildnis B. 's von AERT VAN GELDER (1722). G. S.

Bonnet, Ed. Procès-verbaux constatant la guérison de deux femmes atteintes de maladies vénériennes traitées par GUILBERT DE PRÉVAL (1773). *Janus*, t. 21, 406-409, Leyde 1916 (reprinted *ibidem*, t. 23, 29-32, 1918 !) 1818

Burr, Charles W. JEAN-PAUL MARAT, physician, revolutionist, paranoiac. *Annals of medical history*, t. II, 248-261. New York, 1919. 1818

Cumston, Charles Greene. The legal control of the sale of nostrums and poisons in France during the eighteenth century *Annals of medical history*, II, 396-399, New York 1919. ISIS

Dahlgren, E.-W. Were the Hawaiian islands visited by the Spaniards before their discovery by Captain Cook in 1778? *Kungl. Svenska vetenskapsakademiens handlingar*, Band 57, 4. 223 p, 6 pl., 27 fig. Stockholm 1916. ISIS

After a long and searching analysis of the whole case, DAHLGREN concludes : « No historical fact proves, nor is there any sort of probability, that the Hawaiian islands were ever visited, or ever seen, by the Spaniards before their discovery by Captain COOK in 1778 ». The whole credit of this discovery which inaugurated the investigation of the N. part of the Pacific Ocean, must then be given to COOK. G. S.

Daniëls, C.-É. Beiträge zur Geschichte der Geburtshilfle. I, II *Janus*, t. 20, 41-46, 489-504, Leyde 1915. ISIS

A propos of GEORGE FRIEDRICH MOHR'S « Die gebährende Frau, sammt ihrer Leibes-Frucht in Lebens-Grösse... » Frankfurt 1750, to a certain extent an anticipation of SEMMELWEIS' work of 1861. The second study deals, apropos of the same man, with obstetrical phantoms. G. S.

Delaunay, Paul. La médecine et les idéologues. L.-J. MOREAU DE LA SARTHE. *Bull. soc. franç. hist. méd.*, t. 14, 24-70, 1920. ISIS

LOUIS-JACQUES MOREAU, dit MOREAU DE LA SARTHE (Montfort le Rotrou, 1771—Paris 1826), physician, contributor to the *Encyclopédie méthodique*, editor and biographer of VICQ D'AZYR, commentator of LAVATER, SCHWILGUÉ; he was, with CABANIS, the last of the physicians-philosophers. List of his writings, p. 61-70. G. S.

De Toni, Giovanni Battista. Notizie intorno a GIOVANNI BATTISTA VENTURI ricavate da lettere conservate nella Biblioteca Estense di Modena (Frammenti Vinciani, IX). *Archivio di storia della scienza*, vol. II, 240-247. Roma 1921. ISIS

Two letters (one dated 1808) from G.-B. VENTURI (1746-1822) who will be best remembered as one of the first to study LEONARDO DA VINCI as a man of science in his « Essai sur les ouvrages physico-mathématiques de LÉONARD DE VINCI. Paris, an V (1797) ». G. S.

Erdmann, Benno. BERKELEYS Philosophie im Lichte seines wissenschaftlichen Tagebuchs. *Abhdl. d. preuss. Akad. d. Wiss., philos.-histor. Kl.*, J. 1919, 122 p. Berlin 1919. ISIS

[Euler, Leonhard]. Sur l'état actuel de la publication des œuvres d'EULER. Note d'H. FEHR dans l'*Enseignement mathématique*, 21e année, p. 343-344, Genève 1921. ISIS

Les œuvres complètes d'EULER comprendront près de 70 volumes (*Isis* I, 244; II, 165); 10 volumes en avaient paru avant la guerre; 5 autres volumes ont paru depuis. Pour mener cette immense publication à bonne fin, la Société EULER a besoin de l'appui de nouveaux souscripteurs. Le président de la Société et de la Commission EULER est FRITZ SARASIN de Bâle. G. S.

Lacroix, A. Une note de DOLOMIEU sur les basaltes de Lisbonne, adressée en 1779 à l'Académie royale des sciences. *Comptes rendus de l'acad. des sciences*, t. 167, p. 437-444. Paris 1918. ISIS

Lane, John E. DANIEL TURNER and the first degree of doctor of medicine conferred in the English colonies of North America by Yale college in 1723. *Annals of medical history*, II, 367-380, New York 1919. 1818

Leersum, E.-C. van. Boerhaaviana. *Janus*, t. 21, 445-456, 1916. 1818

I. B. et la poésie; II. Trois lettres de B. G. S.

Lint, J.-G. De. The plates of JENTY. *Janus*, t. 21, 129-135, 4 pl. Leyde 1916. 1818

Apropos of the six remarkable obstetrical drawings issued in 1758 by CHARLES-NICOLAS JENTY of London : *Uteri praegnantis et at partem maturi demonstrationes*. Four are reproduced. G. S.

Loewenfeld, Kurt. Contributions to the History of Science (Period of PRIESTLEY, LAVOISIER, DALTON) based on autograph monuments. *Manchester Memoirs*, vol. 57, 1913, 50 p., 17 pl. 1818

Important original documents, some reproduced in facsimile, concerning the scientists named in the title. G. S.

Mascart, Jean. La vie et les travaux du chevalier JEAN-CHARLES DE BORDA (1733-1799). Episodes de la vie scientifique au XVIII^e^ siècle. Introduction par EMILE PICARD. (*Annales de l'Université de Lyon*, II, 33). 821 p. Lyon, A. Rey, 1919. 1818

La première biographie complète du grand marin et savant BORDA, né à Dax, Landes, en 1733. Cette œuvre est très minutieuse mais prolixe, et il faut tout à fait désapprouver la méthode de l'auteur consistant à donner en notes des notices assez longues des personnages cités. Une biographie n'est pas un dictionnaire biographique, que diable! On comprendrait que l'auteur nous donnât des biographies de personnes relativement peu connues et contemporaines de son héros; il serait assez naturel, en effet, de nous donner des portraits de ceux qui gravitèrent autour de lui. Mais il est tout à fait absurde d'introduire d'autres biographies : qui donc songera à consulter ce livre pour se documenter sur Hipparque, Galilée ou Newton? G. S.

Peachey, G.-C. WILLIAM BROMFIELD, 1713-1792. *Janus*, t. 21, 27-50, 2 portraits, Leyde 1916. 1818

Completes the incorrect notice included in the Dictionary of National Biography. BROMFIELD was a royal surgeon and the author of surgical works, of which PEACHEY gives the bibliography. G. S.

Rolleston, J.-D. The medical interest of CASANOVA's « Mémoires ». *Janus*, t. 22, 115-130, 205-222. Leyden 1917. 1818

Salza, Livia. Un philosophe voyageur du XVIII^e^ siècle. FRANÇOIS-CONSTANTIN VOLNEY. 45 p. Novara, Stab. tipogr. Cattaneo, 1920. 1818

A sketch of VOLNEY'S life and work apropos of the centenary of his death. Born in Craon, Mayenne, 1757, VOLNEY travelled extensively in the Near East and later in the United States and published in 1786 his *Voyage en Egypte et en Syrie*, in 1788 his *Considerations sur la guerre des Turcs*, in 1791 *Les Ruines ou méditations sur les révolutions des empires*, in 1803 the *Tableau du climat et du sol des Etats-Unis*. His was a generous and honest if singular nature. G. S.

Smith, Edgar-C. The centenary [of the death] of NAPOLEON. *Nature*, vol. 107, 302-303, 1921. 1818

A brief review of NAPOLEON's most constructive work, — his encouragement of scientific education and discovery. The author recalls that NAPOLEON himself once said : « The true conquests, the only conquests which cost no regrets, are those achieved over ignorance ». G. S.

Smith, Edgar-F. PRIESTLEY in America, 1794-1804. 173 p. Philadelphia, Blakiston 1920. 1818

An elaborate and interesting account of the last ten years of P. 's life spent in exile in America, after the destruction of his house, library and apparatus by an infuriated mob in Birmingham, 1791. P. arrived in New York on June 4, 1794 and was splendidly received and honoured by the people, the authorities, the learned societies. He finally built himself a house in Northumberland, Pa. (about which see *Isis* III, 342). During his American years P. discovered carbon monoxide, yet he devoted more time to religious than to scientific studies and was blinded by his obstinate devotion to the phlogiston. He was a friend of President THOMAS JEFFERSON, and a few of his letters to him are reproduced, including his « Hints concerning public education ». G. S.

Villaret, Maurice et Moutier, François. Un essai d'anatomie « dynamique » au XVIII^e^ siècle. Les *Tabulae sceleti et musculorum* d'ALBINUS. *Bull. soc. hist. méd.*, t. 15, 205-212. Paris 1921. 1818

BERNARD SIEGFRIED WEISS, dit ALBINUS (Francfort 1697-Leyde 1770) : *Tabulae sceleti et musculorum corporis humani*. Leyde, VERBEEK, 1747. Atlas in-plano de 47 p. et 40 pl. gravées, fruit de longues recherches anatomiques poursuivies de 1725 à 1747. ALBINUS édita avec BOERHAAVE la dernière éd. des *Opera* de VÉSALE 1725 ; il prépara la publication posthume de l'anatomie de BART. EUSTACHI et les défauts de ces travaux antérieurs déterminèrent sa propre activité. Son but fut de publier une anatomie aussi vivante, aussi exacte et aussi didactique que possible. Ses études myographiques sont extrêmement consciencieuses ; il fut le premier à montrer les insertions de chaque muscle. Son collaborateur artistique fut WANDELAAR (Amsterdam 1690—Leyde 175?), élève de GÉRARD DE LAIRESSE. Je possède un exemplaire de cet admirable atlas. G. S.

S. XIX

A. — *Mathematics.*

Amodeo, Federico. Le conseguenze della sfida di FLAUTI : NICOLA TRUDI. *Memoria letta all'accademia pontaniana*, 13 Febr. 1921, 21 p. Napoli. 1818

NICOLA TRUDI (1811-1884), was professor of analysis in Naples. It was FLAUTI's challenge which initiated his mathematical activity (infinitesimal geometry). G. S.

Riemann, B. Über die Hypothesen, welche der Geometrie zu Grunde liegen. Neuhrg. u. erläutert von H. WEYL. VI + 48 p. Berlin, SPRINGER, 1919. 1818

B. — *Physical sciences and Technology.*

Boltzmann, Ludwig. Vorlesungen über die Prinzipe der Mechanik. Dritter Teil. Elastizitätstheorie und Hydrodynamik. Herausgegeben von HUGO BUCHHOLZ. Leipzig, BARTH, 1920. 1818

Vol. I and II appeared in 1897, 1904. G. S.

Cajori, Florian. Swiss geodesy and the United States coast survey. *Scientific Monthly*. August 1921, p. 117-129. 1818

The United States coast survey owes its foundation, in 1807, to the untiring efforts and enthusiasm of a Swiss geodesist, FERDINAND RUDOLF HASSLER of Aarau (1770-1843) who came to the U. S. with his family in 1805. The story of HASSLER's life in America, and of his struggles, is very invigorating. HASSLER improved the geodesic instruments; in the making of maps he used what is now called the American polyconic projection. He presented plans for a national observatory in 1816 to the U. S. government. G. S.

Holleman, A.-F. Fünfzigjähriges Benzolstudium. *Janus*, t. 20, 459-488. Leyde 1915. 1818

Karpinski, Louis C. HERMANN VON HELMHOLTZ. *The Scientific Monthly*, July 1921, p. 23-31. 1818

A stimulating sketch of HELMHOLTZ' work apropos of the centenary of his birth (read at a meeting of the Research Club, University of Michigan). G. S.

Lange, Ernst F. BESSEMER, GÖRANSSON and MUSHET. A contribution to technical history. *Manchester Memoirs*, vol. 57, 1913. 44 p., 6 pl. and 1 facsimile letter. 1818

Explaining the parts played by GÖRAN FREDRIK GÖRANSSON (1819-1900) and ROBERT FORESTER MUSHET (1811-1891) in the successful development of Sir HENRY BESSEMER'S (1813-1898) process of steel-making. G. S.

Lumière, A. et L. Résumé des travaux scientifiques, 1837-1914. 308 p. Lyon. Union photographique industrielle, 1914. 1818

Neumann, Franz. Beiträge zur Krystallonomie aus den Jahren 1823 und 1826. Ein Versuch, den wesentlichen Inhalt dieser vor fast hundert Jahren erschienenen fundamentalen Schriften in übersichtlicher und lückenloser Weise darzustellen von C. NEUMANN. *Abhdl. d. math. phys. Kl. d. k. sächs. Gesell. d Wiss.*, t. 33, 458 p., 22 pl., 66 fig. Leipzig 1916. 1818

I. Methode, den Zusammenhang der Glieder eines Krystallsystems und ihre gegenseitigen Beziehungen graphisch darzustellen, 1823; II. Ueber den eigentümlichen Entwicklungsgang der zwei- und eingliedrigen Krystallsysteme, 1823; III. De lege zonarum, principio evolutionis systematum crystallinorum, 1826. G. S.

Oersted, Hans Christian (1777-1851). Correspondance avec divers savants publiée par M.-C. HARDING. 2 vol. Copenhague, H. ASCHEHOUG, 1920. 1819

Oersted, Hans Christian. Scientific life and works, edited by KIRSTINE MEYER. CLXVI p. Copenhagen, Hoest & Son, 1920 1818

This is a part of the first vol. of OERSTED's Scientific Papers edited by the Royal Danish Society of Sciences. G. S.

Tandberg, J.-G. Ett nyfunnet brev fran H.-C. Örsted. Saertryk af *Fysisk Tidsskrift*, XIX, 4. Hefte. 3 p. [S. a., 1921?] 1918

Tieghem, Ph. van. Notice sur la vie et les travaux de Jean-Baptiste Dumas (1800-1884), 38 p., portrait. *Mémoires de l'Académie des sciences*, t. 52, Paris 1914. 1918

C. — *Natural sciences*

Herwerden, M.-A. van. Eine Freundschaft von drei Physiologen. *Janus*, t. 20, 174-201, 409-436. Leyde 1915. 1918

Deals with three Dutch physiologists : F.-C. Donders (1818-1889), J. Moleschott (1822-1893), I. van Deen (1805-1869). G. S.

Lacroix, Alfred. Notice historique sur Bory de Saint-Vincent (Geneviève-Jean-Baptiste Marcellin). *Mémoires de l'Académie des sciences*, t. 54, 1916, 75 p. avec portrait. 1918

Very elaborate biography with text of documents, bibliographies, etc. — Bory de Saint-Vincent (Agen 1778 — Paris 1846), a traveller and naturalist of great reputation in the first half of the xixth century, is now almost entirely forgotten. Yet he deserves to be remembered, were it only because he was the organiser of two great scientific expeditions in Morea and Algeria. G. S.

Marey, Etienne-Jules (1830-1904). Inauguration du monument élevé à sa mémoire, au Parc des Princes à Boulogne-sur-Seine, le mercredi 3 juin 1914. *Mémoires de l'Académie des sciences*, t. 53, 19 p. Paris 1915. 1918

Discours de Chauveau, Charles Richet, Raymond Poincaré. G. S.

Tieghem, Ph. van. Notice sur la vie et les travaux de Claude Bernard (1813-1878). *Mémoires de l'Académie des sciences*, t. 52, 42 p., portrait. Paris 1914. 1918

Wollaston, A.-F.-R. Life of Alfred Newton (1808-1907). Preface by Sir Archibald Geikie. xv + 332 p. London, Murray, 1921. 1918

D. — *Medical sciences*

Boerner, Paul. Erinnerungen eines Revolutionärs. Skizzen aus dem Jahre 1848. Herausgegeben von Dr. E. Menke-Glückert. 2 Bde. 536 + 319 p. Leipzig, Haberland, 1920. 1918

Paul Boerner was born in 1829 in Jakobshagen, Pomerania; he died in 1885. He was the founder in 1875 of the *Deutsche medizinische Wochenschrift*. G. S.

Herwerden, A. van. Die Freundschaft zwischen [F. C.] Donders [1818-1889] und [Albrecht] von Graefe [1828-1870]. *Janus*, t. 23, 81-94. Leyde 1918. 1918

Lutaud, A. Les médecins dans Balzac, Desplein, Dupuytren. *Bull. soc. franç. hist. méd.*, t. 14, 373-381, Paris 1920. 1918

Desplein, personnage de Balzac, n'est autre que le grand chirurgien Dupuytren. G. S.

Lutaud, A. Le romancier BALZAC et le chirurgien DUPUYTREN. *Janus*, t. 21, 379-405. Leyde 1916. 1818

Le personnage du chirurgien DESPLEIN si souvent introduit par BALZAC dans ses romans lui a été inspiré par la grande personnalité de DUPUYTREN (Limousin 1778-1835). G. S.

Pleadwell, Frank Lester. WILLIAM PAUL CRILLON BARTON, surgeon United States navy, a pioneer in American naval medicine (1786-1856). *Annals of medical history*, II, 267-301, NewYork 1919. 1818

Rosenbloom, Jacob. An appreciation of HENRY BENCE JONES, M. D., F. R. S. (1814-1873). *Annals of medical history*, t. II, 262-264, New York 1919. 1818

The English physician JONES was one of the first modern ones « to value chemistry as an aid in the explanation and cure of disease ». He was a great friend of FARADAY, whose life he wrote (2 vol.); also the friend and physician of DARWIN and HUXLEY, etc. He was the first to describe the occurrence of xanthine in urine. G. S.

E. — *Alia*

Goulard, Roger. Essai médical sur PAUL-LOUIS COURIER [1773-1825]. *Bull soc. franç. hist. méd.*, t. 15, 139-169. Paris 1921. 1818

Lucas, Frederic A. Glimpses of early museums. *Natural history*, t. 21, 74-77, New York 1921. 1818

Apropos of the BULLOCK'S museums which flourished in London from 1795 to 1824, from Major W.-H. MULLENS' account in the *Museums Journal*, vol. 17, with two illustrations. G. S.

Nass, Lucien. Le siège de Paris et la Commune (Essai de psychologie historique). II + 360 p. Paris, Plon, 1914. 1818

« L'auteur se borne à la clinique historique. Il argumente, non pas en historien — ce qu'il se défend d'être, — mais en médecin, les phénomènes morbides provoqués dans l'organisme social par des événements exceptionnels, tels que le siège d'une ville de deux millions d'âmes et l'insurrection qui suit la capitulation. Il cherche à établir l'étiologie de cette maladie, il la suit dans ses symptômes et son évolution jusqu'au dénouement de la crise et à la guérison... » G. S.

Parodi, Dominique. La philosophie contemporaine en France. Essai de classification des doctrines, VI + 502 p. Paris, ALCAN 1919. 1818

Vecchio-Veneziani, Augusta Del La vita e l'opera di ANGELO CAMILLO DE MEIS. XXIV + 333 p. Bologna, ZANICHELLI, 1921. 1818

Biographie sympathique du grand philosophe et historien de la médecine ANGELO CAMILLO DE MEIS, né à Bucchianico, près de Chieti en 1817, mort en 1891. C'était un philosophe hégélien, grand ami de FRANCESCO DE SANCTIS et de BERTRANDO SPAVENTA. Après une carrière agitée et de longues années d'exil il devint professeur d'histoire de la médecine à Bologne et son influence y fut considérable : il n'a pas été remplacé. DE MEIS était un savant, un philosophe, un grand patriote, un homme de bien — il faudrait dire, un saint, et sa vie et sa mort sont également édifiantes. Les questions

qui l'ont le plus occupé sont la lutte contre le positivisme et le darwinisme et surtout les rapports entre la philosophie et la médecine. Cette dernière l'a occupé toute sa vie. De Meis était plutôt un philosophe qu'un historien. La biographie du Dott. Del Vecchio est très complète. Elle contient une bibliographie et un beau portrait. G. S.

S. XX

Schwarte, M. (Generalleutnant z. D.) (*editor*). Die Technik im Weltkriege. Unter Mitwirkung von 45 technischen und militärischen sachwissenschaftlichen Mitarbeitern. Mit vielen Skizzen und Abbild. x + 610 p. Berlin, Mittler, 1920. 1818

An elaborate account, sober, authoritative, well illustrated, divided into 3 main parts : A) War on land; B) Naval war; C) Home industries. Each chapter is contributed by a specialist. The book is thus a survey of technological knowledge c. 1918. G. S.

Yerkes, Robert M. (*editor*). The new world of science. Its development during the war. xx + 443 p., illustrated. New-York, Century, 1920. 1819

A study by various specialists of the rôle played by the different sciences in war. It will be particularly interesting for the historian of the year 2500 A. D., studying the strange perversity of the scientists of the beginning of the xxth cent. It is divided as follows : Generalities (at the beginning and the end, by G.-E. Hale and J.-R. Angell); Physical science (by R.-A. Millikan, Aug. Trowbridge, H.-E. Ives, H.-E. Howe); Chemistry (by A.-A. Noyes, Ch.-E. Munroe, Cl.-J. West); Earth Sciences (by D.-W. Johnson); Engineering (by A.-E. Kennelly, Henry-M. Howe); Biology and medicine (by Vernon Kellogg, Fr.-F. Russell, J.-W. Hanner, V.-C. Vaughan); Psychology (by R.-M. Yerkes). G. S.

PART II

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Historical classification.

1 and 2. — ANTIQUITY

Dieulafoy, Marcel. Quarante. *Comptes rendus de l'Académie des inscriptions*, 1919, p. 13-23. 1818

On the importance attached in antiquity to the number 40. G. S.

Jeanselme, Edouard. Quels étaient les principes d'hygiène et les remèdes en usage parmi les populations agricoles de l'antiquité d'après les Géoponiques. *Bull. soc. d'hist. de la méd.*, t. 15, 7-16, Paris 1921. 1818

Moulé, Léon. Les fraudes pharmaceutiques dans l'antiquité. *Bull. soc. franç. hist. méd.*, t. 14, 199-226. Paris 1920. 1818

Nagl, Alfred. Die Rechentafel der Alten. *Wien, Akad. d. Wissensch., philos.-histor. Kl., Sitzungsberichte*, t. 177, 86 p. Wien 1914.

1813

An important study on the use of the abacus in Greek and Roman times. G. S.

Neuburger, Albert. Die Technik des Altertums. Zweite, verbesserte Aufl. mit 676 Abb. XVIII + 570 S. Leipzig, VOIGTLAENDER 1921.

1813

The first ed. appeared in 1919 (I did not see it); the second ed. apparently is essentially the same but with many improvements in the details. The subject is divided as follows : Der Bergbau. Die Metalle und ihre Gewinnung. Die Bearbeitung der Metalle. Die Bearb. des Holzes. Die Herstellung und Verarbeitung des Leders. Der Ackerbau. Die Gärungstechnik. Die Technik der Oele, Fette, Seifen und Wohlgerüche. Kältetechnik und Konservierung. Die Keramik. Das Glas. Gespinste und Gewebe. Die Farbstoffe. Die Maltechnik. Technische Mechanik und Maschinen. Feuerzeuge, Beleuchtung und Heizung. Städtebau. Befestigungen. Städtische Strassen und Plätze. Die Häuser. Monumental- und öffentliche Bauten. Bauarten, Bauausführungen und Baustoffen. Die Baumaterialien. Die Wasserversorgung. Die Kanalisation. Bewässerung und Entwässerung. Strassen und Brücken. Schiffe und Schiffbau. Schiffahrt. Die Häfen. — Each chapter is followed by a short bibliography and there are abundant illustrations. G. S.

Neveu, Raymond. La lutte antipaludique chez les Etrusques. *Bull. soc. franç. hist. méd.*, t. 14, 102-107. Paris 1920. 1813

Sethe, Kurt. Der Ursprung des Alphabets. *Nachrichten von der kgl. Ges. d. Wiss. zu Göttingen, Geschäftliche Mitt.*, 1916, 88-161.

1813

In favor of the Egyptian origin. G. S.

Soutzo, Michel. Notice sur les origines et les rapports de quelques poids assyro-chaldéens. *Comptes rendus de l'Académie des inscriptions*, Paris 1919, 150-157. 1813

4. — BABYLONIA and ASSYRIA

Langdon, S. The Babylonian conception of the Logos. *Journal of the R. Asiatic Society*. London 1918, p. 433-449. 1813

The Babylonians regarded water as the uncreated first principle and the word chosen to represent it was originally voice, loud cry... THALES may have borrowed his own philosophy from Babylonia. We do not know whether he identified water with *logos*, but HERACLITUS posited fire as his first principle and identified it with *logos*, or reason. G. S.

Scheil, Le. P. La chronologie rectifiée du règne de HAMMOURABI. [vers 2100 av. J.-C.] *Mémoires de l'Académie des inscriptions*, t. 39, p. 111-122. Paris 1914. 1813

Scheil, V. Recueil de lois assyriennes. Texte assyrien en transcription avec traduction française et index. 125 p. autographiées. Paris, GEUTHNER, 1921. 1813

This Assyrian code dating of the XIVth or XIIIth cent. B. C. was found on three tablets excavated by the Germans in Assur; a facsimile reproduction

of them was published by E. Schröder in his *Keilschrifttexte aus Assur*, 1920. The discovery of this code may be said to be the greatest event, for the historian of ancient law, since the publication of Hammurabi's code in 1902. Scheil's book contains the first decipherment of this code, together with a French translation and index. For any one recalling Hammurabi's code (of c. 2100 B. C.), this new Assyrian one is very depressing; for it illustrates the terrible moral and social decadence which had taken place in the meanwhile. See Morr. Jastrow. An Assyrian law code in *Journal of the American Oriental Society*, vol. 41, 1-59, 1921. G. S.

5. — BIBLE

(*Old Testament Civilization.*)

Macdonald, D.-B. The pre-Abrahamic stories of Genesis as a part of the Wisdom literature. *Studia semitica et orientalia*, Glasgow, 1920, p. 115-125. 1818

The author claims these chapters for the so-called Wisdom literature (*i. e.*, Ecclesiastes, Enoch, II Esdras, Paul), makes a very clear statement of the essential nature of that literature, then analyzes the eleven first chapters of Genesis. This is important for the study of the dawn of science. G. S.

Wood, Percival. Moses. The founder of preventive medicine XI+116 p. London, Society for promoting Christian knowledge, 1920. 1818

6. — BYZANTIUM.

Ebersolt, Jean. Constantinople Byzantine et les voyageurs du Levant. Paris, Leroux, 1918. 1818

Jeanselme, E. La goutte à Byzance. *Bull. soc. franç. hist. méd.*, t. 14, 137-165. Paris 1920. 1818

7. — CHINA

Andersson, J.-G. The national geological survey of China. *Natural history*, t. 21, 4-12, New York 1921. 1818

An illustrated account of this most hopeful undertaking, a child of the Chinese revolution. It originated at Nanking 1911, Dr. H.-T. Chang being the first chief. Upon the removal of the central government to Peking, Chang became director of a school for the training of surveying geologists, while Dr. V.-K. King was appointed director of the national geological survey. Prof. J.-G. Andersson, late director of the geological survey of Sweden, is curator of the museum of the geological survey of China. Our every good wish to them! G. S.

Andrews, F.-H. Ancient Chinese figured silks excavated by Sir Aurel Stein at ruined sites of Central Asia. 20 p. London, Quaritch, 1920. 1818

Cordier, Henri. Histoire générale de la Chine et de ses relations avec les pays étrangers depuis les temps les plus anciens jusqu'à

la chute de la dynastie mandchoue. 4 vol., Paris, PAUL GEUTHNER, 1920-1921. 1918

T. I, 574 p., jusqu'à la chute des T'ang, 907; T. II, 434 p., jusqu'à la chute des Mongols, 1368; T. III, 428 p., jusqu'à la mort de KIA K'ING, 1820; T. IV, 427 p. G. S.

Davis, Andrew McFarland. Certain old Chinese notes. *Proc. Americ. Acad. of Arts*, t. 50, 243-286; illust. Boston 1915. 9191

Paper money was used in China as early as the IXth cent., and possibly as the seventh. DAVIS discusses the question, describes specimens, explains China's early economic experiments with paper money and compares them with similar events which took place in Massachusetts in the first half of the XVIIIth cent.

Davis, Andrew McFarland. Ancient Chinese paper money as described in a Chinese work on numismatics. *Proc. Amer. Ac. of Arts*,, t. 53, 465 647, Boston 1918. 1918

Completing the preceding note with a translation by KOJIRO TOMITA of the *Ch'üan Pu T'ung Chih*, 1833, describing and illustrating many Chinese notes ranging from c. 650 to 1425. G. S.

Giles, Herbert A. Supplementary catalogue of the Wade collection of Chinese and Manchu books in the library of the University of Cambridge. Cambridge, University Press, 1915. 1918

List of the books obtained since 1898, when the Catalogue was published; more than 1300 volumes. The most precious item is the collection of the poetical and prose works of TU FU (712-770), with many commentaries, printed in 1204 in 24 vol. G. S.

Groot, J.-J.-M. De. Der Thûpa, das heiligste Heiligtum des Buddhismus in China. Ein Beitrag zur Kenntnis der esoterischen Lehre des Mahâyâna. *Abhdl. d preuss. Akad. d. Wiss., philos.-histor. Kl.*, J. 1919, 96 p., 6 pl. Berlin 1919. 1918

Herrmann, Albert. Die ältesten chinesischen Karten von Zentral- und Westasien. HIRTHS Festschrift, Berlin 1920, p. 185-198, (4 maps). 1918

A preliminary note about the author's researches in Chinese and Central Asian cartography; a more elaborate memoir to appear in SVEN HEDIN. Southern Tibet. Discoveries in former times, vol. VIII, Stockholm 1920. 1. Karten aus der Zeit der Han-Dynastie; 2. Das Wei-Si-yü-t'u; 3. Das Sui-Si-yü-t'u. G. S.

Hirth, Friedrich. Festschrift zu seinem 75 Geburtstag. 16. April 1920. 402 S., Bildn., 54 Abb , 1 Karte. Berlin, OESTERHELD 1920.

Contains a bibliography of HIRTH'S writings (1869 to 1917, 106 items). The papers of this Festschrift of interest to us are mentioned in the present bibliography. G. S.

Hülle, H. Die Erschliessung der chinesischen Büchershätze der deutschen Bibliotheken. HIRTHS Festschrift, Berlin 1920, p. 199-219. 1918

[I-Li]. The I-Li or book of etiquette and ceremonial. Translated from the Chinese with introduction, notes and plans by JOHN STEELE.

2 vol. illustr., XXIV + 288 p., VIII + 242 p. London, PROBSTHAIN, 1917. 1818

The first complete translation of the *I-Li*. G. S.

Reismüller, Georg. Zur Geschichte der chinesischen Büchersammlung der Bayerischen Staatsbibliothek. HIRTHS Festschrift, Berlin 1920, 331-336. 1818

[**Rockefeller Foundation**, China medical commission] Medicine in China. VIII + 113 p. New York 1914 (second impression 1915). 1818

1. Health conditions in China; 2. Chinese native medicine and surgery (very brief note with reference to G.-A. STUART. Chinese materia medica, Shanghai 1911); 3. Western medicine in China; 4. Standards of medical education under missionary auspices. Teaching in Chinese or in English (conclusion : the teaching in English will take a longer time than the other, but in the long run will secure the largest and best results); 5. Dissection and autopsies; 6. Attitude of the Chinese toward modern medicine; 7. Recommendations (a magnificent program of work, which will be an eternal credit to the ROCKEFELLER foundation and to America). Appendixes. There were, in 1914, 446 Western doctors (men and women) in China, plus 140 foreign nurses. G. S.

Saussure, Léopold de. The calendar of the Muh T'ien Tsz Chuen. *The new China review*, vol. II, 513-516, Shanghai 1920. 1818

This text, written on flat pieces of wood, was discovered in the third century in the tomb of a prince, which had been opened by thieves. The greater part of it deals with a long sporting trip which lasted two years, during which King MUH paid a visit to Si-wang-mu (949 to 946 B. C., or 988 to 985 B. C. G. S.

Schindler, Bruno. Das Priestertum im alten China. 1. Teil : Königtum und Priestertum im alten China. Einleitung und Quellen. (*Diss.*) Leipzig, SPAMER 1918 (?). 1818

8. — EGYPT

Bates, Oric. Ancient Egyptian fishing. *Harvard African studies*, vol. I. 199-271, 26 pl. Cambridge, Mass. 1917. 1818

A very elaborate study based mainly on archæological material, much of which is reproduced in the plates. BATES has dealt also with the chase of the hippopotamus, for these animals were hunted in boats and with harpoons often indistinguishable from those employed in the capture of large fish. The implements studied by the author carry us back very nearly to the beginning of the predynastic period. Contents : Sources; economic importance; religious aspects; papyrus canoe; harpoon; bident (two-pronged fish spear); hook and line; weel (wicker fish trap); hand net; cast net; double hand net; seine; fish curing; fisherman; conclusion. G. S.

Gennep, A. van et Jéquier, G. Le tissage aux cartons et son utilisation dans l'Egypte ancienne. 130 p. in-f°, 5 planches en couleurs, 135 illustr., 1 planche de rubans tissés en coton-soie, reproduisant des motifs égyptiens. Neuchâtel. DELACHAUX et NIESTLÉ, 1916. [125 exemplaires]. 1818

Cette étude est d'un grand intérêt pour l'historien de la technologie,

mais aussi pour l'historien de l'art car la plupart des motifs décoratifs employés par les anciens Egyptiens furent empruntés à l'art du tisserand (certains à l'art du vannier). Le plus ancien métier à tisser connu date du Moyen Empire (environ 2200), c'est un métier horizontal : un autre métier — vertical celui-là — date du Nouvel Empire (1500-1000). Il est probable que de pareils métiers étaient déjà employés dès l'Ancien Empire. Les étoffes considérées dans le présent travail sont plutôt des rubans ou des galons, et des métiers spéciaux ont dû être utilisés pour les faire. Pour résoudre ce problème, les auteurs ont fait une étude comparative du tissage aux cartons chez les Égéens, les Syriens et dans l'Egypte copte. G. S.

Hamburger, Ove. Zwei Darstellungen von Krankheiten aus dem alten Ægypten. *Janus*, t. 19, p. 241-245, 2 pl. Leyde 1914. 1918

Apropos of a stele of the 18th Dyn. of the Ny Carlsberg Glyptoth. representing a man with an emaciated leg, and of the statue of King MENTHUHOTEP in a tomb nr. Thebes with legs and feet of enormous size. G. S.

Hooton, E.-A. Oral surgery in Egypt during the Old Empire. *Harvard African studies*, vol. 1, Cambridge 1917, p. 29-32, 2 pl. 1918

The specimen examined by the author establishes beyond a reasonable doubt the existence of a rudimental knowledge of oral surgery in the Old Empire. This specimen was discovered by Dr. K.-H. THOMA; it is a mandible belonging to a fragmentary skeleton from an Old Empire tomb excavated by G.-A. REISNER at Giza and now in the PEABODY Museum, no. 59303. G. S.

Sterns, F.-H. The paleoliths of the Eastern Desert. *Harvard African studies*, vol. I, 48-82, 1 map, 18 pl. Cambridge, Mass. 1917. 1918

Discussion of the flint implements discovered by G.-W. MURRAY in 1914 in the Eastern Desert of Egypt, now in the PEABODY Museum. G. S.

9. — GREECE

Bell, Edward. Hellenic architecture. Its genesis and growth XX + 185 p. London, BELL, 1920. 1918

Bianchi, Lorenzo. Der Kalender des sogenannten CLODIUS TUSCUS (Griechische Kalender hrg. von FRANZ BOLL, 4). *Sitzungsberichte d. Heidelberger Akad. d. Wiss., philos. hist. Kl.*, t. 5, 1914, 56 p. 1918

Is the Greek text of this calendar a translation by LYDUS of a Latin original, or did LYDUS follow a Greek original? BIANCHI claims that the second hypothesis is the true one. According to him the original source of all ancient calendars is the EUDOXI *et* METONIS *antiquorumque fasti astrologorum*. From this source derived : 1. Greek popular tradition ; 2. *Vetus calendarium rusticum Romanum*. From 2 derived : VARRO, COLUMELLA, OVIDIUS, POLEMIUS SILVIUS. WACHSMUTH on the other hand does not recognize the popular tradition, and for him the so-called CLODIUS calendar derives from 2, in the same way as VARRO's, etc. G. S.

Capelle, Wilhelm. Berges- und Wolkenhöhen bei griechischen Physikern. (*Stoicheia*, 5), 47 p. Leipzig, TEUBNER, 1916. 1918

Günther, Siegmund. Die antike Apokatastasis auf ihre astronomischen und geographischen Grundlagen geprüft. *Bayer. Akad. d. Wiss., Sitzungsber. d. math. phys. Kl.*, München 1916, 83-112. 1918

The Greek notion of ἀποκατάστασις (*restitutio in integrum*) was relative both to astronomical and to geographical (*ex. gr.* periodical floods) periods, but they never tried to establish an internal relation between the celestial and terrestrial phenomena. GÜNTHER studies the development of this notion in Greek and also in later times. 1. Begriffsbestimmung; 2. A. in ihrer Abhängigkeit vom Sterrenhimmel; 3. Wesen und Erklärungsversuche der Ueberflutungen; 4. Wechselwirkung zwischen Himmel und Erde. G. S.

Luce, Stephen Bleecker. A brief history of the study of Greek vase-painting. *Proc. of the Amer. philos. soc.*, t 57, 649-668. Philadelphia 1918. 1918

One finds the first references to painted vases in the *Museum Romanum* of LA CHAUSSE 1690 and at about the same time in GRAEVIUS' *Thesaurus;* some are published in MONTFAUCON'S *L'antiquité expliquée*, Paris 1719. The oldest album of Greek vases is GIOV. BAT. PASSERI. *Picturae Etruscorum in vasculis*, 3 vol., 1767-1775. The first accurate album is perhaps TISCHBEIN'S *Vases d'Hamilton*, 1791-1803... First scientific catalogue OTTO JAHN, Pinakothek of Munich, 1854 .. A list of museums containing Greek vases follows. G. S.

Moïssides (de Constantinople). La puériculture et l'eugénique dans l'antiquité grecque. III. Après la naissance. *Janus*, t. 19, 289-311. Leyde 1914. 1918

Neveu, Raymond. Le culte d'ESCULAPE et d'HYGIE dans les îles de la mer Egée. *Bull. soc. hist. méd.*, t. 15, 189-198. Paris 1921. 1918

Nilsson, Martin P. Die Entstehung und religiöse Bedeutung des griechischen Kalenders. *Acta Universitatis Lundensis*, XIV : 2, 65 p. Lund 1918. 1918

Rehm, Albert. Griechische Windrosen. *Sitzungsber. d. Bayer. Ak. d. Wiss., philos.-phil. Kl.*, München 1916, 104 p. 1918

1. HOMER and the prescientific period; 2. The Ionian physicists; 3. ARISTOTLE; 4. TIMOSTHENES; 5. The Hellenistic system of 8 winds; 6. POSEIDONIOS. — The fragment ἀνέμων θέσεις. G. S.

Rolleston, J.-D. The medical aspects of the Greek anthology. *Janus*, t. 19, p. 35-45, 105-131. Leyde 1914. 1918

Roscher, Wilhelm Heinrich. Neue Omphalosstudien. *Abhdl. d. Gesell. d. Wiss., philol. hist. Kl.*, t. 31, 7 pl., 90 p. Leipzig 1915. 1918

1. Ueber die Etymologie von ὀμφαλός und die Bedeutung des Nabels bei den Griechen und andern Völkern; 2. Der Gedanke eines Zentrums (Nabels) der Erdoberfläche bei verschiedenen Völkern; 3 Branchidai (Didyma) und sein Orakel als Nabel der Erde; 4. Delphi und sein Orakel als Mittelpunkt der Welt und sein Nabelstein; 5. Weitere wahrscheinlich nicht von Delphi abhängige Kulte des APOLLON, ASKLEPIOS usw., in denen Omphaloi vorkamen; 6. Grabmonumente in Omphalosform; 7. Problematische Omphaloi. G. S.

Withington, E.-T. The Asclepiadae and the priests of Asclepius. *Studies in the history and method of science*, vol. II, 192-205. Oxford 1921. 1918

The author gives some additional reasons for rejecting the superficial view that Hippocratic medicine « originated in the health temples ». G. S.

Zeuthen, H.-G. Sur l'origine historique de la connaissance des quantités irrationnelles. *Bull. de l'Académie royale de Danemark.* Copenhagen 1915, p. 333-362. 1918

A comprehensive account and discussion of this moot subject, with bibliography. G. S.

10. — INDIA

Binyon, Laurence. The court painters of the Grand Moguls. With historical introduction and notes by T.-W. Arnold. 86 p., 40 pl. (many in colour). Oxford University Press 1921 [s. 63]. 1918

A splendid collection of reproductions of these Mogul paintings, chiefly portraits, of the XVIth and XVIIth cent. Though far less charming and less impressive than the Rajput paintings, these paintings are very beautiful. To call them Indo-Persian is misleading; they are really Hindu, though with traces of Persian influence in the earliest of them and of European influence in the latest. It is interesting to note that the earliest evidence of the importation of these paintings in Europe is found in drawings made by Rembrandt c. 1640-1650. A very suggestive account by L. Binyon is preceded by an historical outline by Arnold. The latter has also contributed notes to the paintings reproduced, chiefly biographical. The lack of an index is regrettable. G. S.

Bloomfield, Maurice. On the art of entering another's body : a Hindu fiction motif. *Proc. of Amer. philos. soc.*, t. 56, 1-43. Philadelphia 1917. 1918

Faddegon, B. The Vaiçesika-system described with the help of the oldest texts. *Verhand. d. K. Akad. van Wetenschappen, Afd. Letterkunde*, t. 18, 614 p. Amsterdam 1918. 1918

Elaborate study of this system of philosophy, to which much less attention has been devoted than to the Vedânta and the Sâmkhya-Yoga, although it is certainly not less important for the understanding of Indian science. Book II contains an exposition of the system divided as follows : 1. Metaphysics; 2. Physics; 3. Mathematical notions (number, time, space, movement); 4. Psychology; 5. Sources of knowledge; 6. Ethics and theology. Comparisons are made with the other Indian and European systems. Important. G. S.

Fleming, Daniel Johnson. Schools with a message in India. 210 p. illustr. Oxford University Press 1921 1918

Hume, Robert Ernest. The thirteen principal Upanishads, translated from the Sanscrit with an outline of the philosophy of the Upanishads and an annotated bibliography. 556 p. Oxford University Press 1921. 1918

Ojha, Rai Bahadur Pandit, **Gaurishankar Hirachand.** The Palæography of India. Second ed. revised and enlarged. Ajmer. Scottish Mission Industries Co., 1918. 1818

See review by J. Ph. V. in *Journal R. Asiatic Soc.*, 1919, 617-619.

Oldenberg, Hermann. BUDDHA. Sein Leben, seine Lehre, seine Gemeinde. 6. Auflage. Berlin 1914. 1818

First ed., 1881; 2nd. 1890; a seventh revised ed. has appeared recently (c. 1920). G. S.

Stevenson, Mrs. (**Margaret**) **Sinclair.** The rites of the twice-born. (*The religious quest of India*). XXIV + 474 p. Oxford University Press, 1920. 1818

Vidyabhusana, M.-M. Satis Chandra. Influence of ARISTOTLE on the development of the syllogism in Indian logic. *Journal R. Asiatic Society*, London 1918, 469-488. 1819

The works of ARISTOTLE were very well known in India during the first six centuries of our era. G. S.

11. — IRAN

Diez, Ernst. Churasanische Baudenkmäler. 1. Bd. (*Arbeiten des kunsthistorischen Instituts des Universitäts Wien*, 7) XII + 116 p., 41 pl. Berlin, REIMER, 1918. 1819

12. — ISLAM

Goldziher, Ignaz. Stellung der alten islamischen Orthodoxie zu den antiken Wissenschaften. *Abhdl. d. preuss. Akad. der Wissensch.*, J. 1915, *Philos.-hist. Kl.*, Nr. 8, 46 p. Berlin 1916. 1818

Explains the increasing distrust felt by the orthodox Moslems of the Eastern Caliphate against the *'ulūm al-awā'il* or *'ulūm al-qudamā* (the sciences of the ancients), that is, chiefly Greek science, or else positive (vs. theological) sciences. The harassing of AL-KINDI under MUTAWAKKIL is likely the earliest example of the growing intolerance. G. S.

Hess, J.-J. Der arabische Ausdruck für Zuckerrohr in el-Jemen. *Sitzungsber. d. physik. mediz. Gesell.*, t. 48, 87-88, Erlangen 1918. 1818

Jaussen et **Savignac** (RR. PP.). Mission archéologique en Arabie, II. El-'Ela, d'Hégra à Teima, Harrah de Tebouk. 3 parties gr. in-8°. Paris, GEUTHNER 1914 [1920]. 1818

T. I, XV + 690 p. Itinéraire et archéologie; T. II, 153 planches et cartes; T. III, 97 p. Les coutumes des Fuqara. G. S.

Kremer, Alfred von. The Orient under the Caliphs. Translated by S. KHUDA BUKHSH. XIV + 463 p. University of Calcutta 1920. 1818

This is supposed to be a complete translation of Baron von KREMER's classical work « Culturgeschichte des Orients unter den Chalifen », 2 vol.

XII + 548 p., 517 p. Wien 1875-1877. At least, as the author does not say a word to the contrary, the reader will likely believe that the translation is complete. In fact we are simply given a transl. of chapters 1 to 6, 8 and 9 (out of 19 chapters). Chapter 7 devoted to Finances has been omitted without any warning! It seemed unnecessary to carry the comparison further. As far as scholars are concerned this translation is non-existent. Such half-baked work is not to the credit of the University of Calcutta. G. S.

Meyerhof, M. Die Optik der Araber Ein Sammelbericht. *Zeitschrift für ophthalmologische Optik*, J. VIII, 16-29, 42-54, 86-90. Berlin 1919 [reprint dated 1920]. 1818

A very important memoir giving in brief compass a comprehensive survey of Islamic optics. The Moslems who contributed to the progress of optics belonged to one of the five following categories: 1. Translators; 2. Natural philosophers; 3. Mathematicians; 4. Oculists; 5. Encyclopædists. MEYERHOF considers successively these five categories, devoting a special paragraph to each important personality. G. S.

Stevenson, William Barron. Some specimens of Moslem charms. *Studia semitica et orientalia*, Glasgow, 1920, p. 84-114. 1818

1. The seven sleepers; 2. Charm of Murjanë (Morgana); 3. A Damascus charm roll; 4. SOLOMON and the evil eye; 5. Magic squares in Arabic charms; 6. The seven seals (one of these mysterious signs, called « the seal of the five corners », is the Pythagorean pentagram). G. S.

Wiedemann, Eilhard. Ueber von den Arabern benutzte Drogen. (Beiträge zur Gesch. der Naturw., 49). *Sitzungsber. d. physik. medizin. Sozietät*, t. 48-49, p. 16-60. Erlangen 1918. 1818

This essay written with the collaboration of ADOLF GROHMANN, Vienna, is essentially a translation of the chapters relative to drugs in the great encyclopædia published by AL NUWAIRÎ (d. 1332) of Tripolis, with commentary, including biographic and geographic notes. A chapter deals with the examination and falsification of drugs according to ABŪ MUNÂ AL 'ATṬAR, who fl. c. 1260 in Cairo. See also under S. XIV, p. 407. G. S.

Wiedemann, Eilhard. Ueber die Kriechtiere nach AL QAZWINI nebst einigen Bemerkungen ueber die zoologischen Kenntnisse der Araber (Beitr. zur Gesch. d. Naturw., 53). *Sitzungsber. d. physik. medizin. Ges.*, t. 48, 228-285, Erlangen 1918. 1818

I. Einleitung — Ueber Mineralogie und Botanik. Allgemeines über Zoologie. Quellen für die arabische Zoologie: AL GÂḤIẒ (d. 869); AL DAMÎRÎ [1344-1405]; AL QAZWÎNÎ [1203-1283]; AL NUWAIRÎ (d. 1332); AL ABSCHÎHÎ (d. 1440); die getreuen (lauteren) Brüder (c. 950-1000); AL AGDABÎ (d. 1203); Schriften über Tierheilkunde. Von den Arabern behandelte Tierarten. Sammlungen lebender Tiere.

II. AL QAZWÎNÎ über die Kriechtiere und Insekten... (Uebersetzung und Bemerkungen).

III. Stellen aus AL QAZWÎNÎ über Wassertiere und AL DÎNAWARÎ [d. 895] über Insekten.

IV. Beziehungen zwischen Tier und Mensch. G. S.

Wiedemann, Eilhard. Ueber den Zucker bei den Muslimen. (Beitr. zur Gesch. d. Naturw., 52). *Sitzungsber. d. medizin. Gesell.*, t. 48, 177-185, Erlangen 1918. 1818

1. Orte, an denen Zucker vorkommt; 2. Frühe Erwähnung des Zuckers;

3. Zuckerpressen; 4. Zucker in Rechenaufgaben; 5. Qatr und Qatr 'Asal; 6. Sukkar, Ṭabarzad u. s. w. als Dattelarten; 7. Ueber Zucker u. s. w. ausscheidende Pflanzen — Nachträge (Beitr., 55) *ibidem*, 322-328.

G. S.

Wiedemann, Eilhard. Ueber Parfüms und Droge bei den Arabern. (Beitr. zur Gesch. d. Naturw., 56). *Sitzungsber. d. physik. mediz. Ges.*, t. 48, 329-344. Erlangen 1918. 1818

1. Zahl der Parfüms; 2. Einzelne Parfüms; 3. Verzeichnis der Parfüms bei Abû'l Qasim und Waschscha; 4. Allgemeines über Parfüms. Bemerkungen von Prof. Hess in Zürich und J.-W.-C. Gorthart. G. S.

Wiedemann, Eilhard. Zur Geschichte des Kompasses bei den Arabern. *Verhdl. der deutschen physik. Gesellschaft*, 1919, 665-667. 1818

This is the third paper by Wiedemann on this subject (see *ibidem*, t. 9, 764, 1907 and t. 11, 202, 1909). There are but few Arabic descriptions of the compass. Wiedemann reproduces the often quoted description published in 1282 by Bailak al Qabagaqi, referring to the use of the compass at sea in 1242; he gives a new description not very different from the first, extracted from a Berlin MS. dated 1702. G. S.

Wiedemann, Eilhard. Ueber die angebliche Verwendung des Pendels zur Zeitmessung bei den Arabern. *Verhdl. d. Deutschen physik. Gesell.*, 1919, p. 663-664. 1818

Discussing the often repeated statement that the Arabs used the pendulum for time measurement already c. 1000. The source of this statement is Ed. Bernard, *Phil. Trans.*, London, t. 14, 567, 1684. Wiedemann has found nothing in his long studies to substantiate it. G. S.

Wiedemann, Eilhard. Bestimmung der Durchmesser der um und in regelmässige Vielecke beschriebenen Kreise und des Inhaltes von Flächen und Körpern sowie Stücke einer Lehre al Gabr wa'l Muqâbala. (Beiträge zur Gesch. d. Naturwiss, 58). *Sitzungsber. d. physik. med. Sozietät*, Bd. 50-51. Erlangen 1918-1919, p. 264-271; Gefäss zum Regeln des Wasserausflusses bei Wasseruhren. (Beitr..., 59). *Ibidem*, p. 272-274. 1818

Two more extracts from the Paris MS., Slane, no. 2468, translated and annotated. — The contrivance described in the second one is more perfect than that of the Pseudo Archimedes and similar to Gazari's. The names of the months are Syriac. G. S.

Wiedemann, Eilhard. Eine Sonnenfinsternis, ein Erdbeben, ein Meteor und ein Meteorstein nach arabischen Quellen. *Das Weltall*, J. 20, 154-155, 1920. 1818

The three first observations are related by Ibn al Athir (1160-1234) in his Universal History. He himself observed the sun eclipse on Ramadan 29, 571 (April 11, 1176) in his native place Gazira ibn Omar upon the Tigris. The fall of a meteoric stone is reported by Ibn Battûta (1303-1377). G. S.

Wiedemann, Eilhard. Einleitungen zu arabischen astronomischen Werken. *Das Weltall*, 20. J., 21-26, 131-134; 1919-1920. 1818

The Introductions to the Moh. scientific works are of great philosophic interest. Wiedemann gives us here annotated translations of the following introductions: al Farghâni's introd. to a book on the astrolabe (first half of the ixth cent.); introd. of al Bîrûni to a memoir on all the possible

methods of constructing the astrolabe (first half of the XIIth cent.); introd. of another work on the astrolabe by the same; introd. to the astronomic tables (al zîg al gâmi) by ABUL HASAN KUSCHJÂR B. LABBÂN B-BÂSCHAHRÎ AL GÎLÎ (= from Gilan) who fl. c. 971-1029 (see SUTER no. 192 and WIEDEMANN, Beitr., no. 43); introd. to a writing on the Indian circle (i. e. a gnomon in the center of a circle) by HUSAIN B. AL HUSAINÎ AL CHALCHÂLÎ († 1014 or 1030). G. S.

Wiedemann, E. (unter Mitwirkung von E. SEIDEL und O. RESCHER). Zur Geschichte des Bades und des Badens bei den Orientalen. *Z. f. physikalische und diätetische Therapie*, Bd. 24, 239-248, Leipzig 1920. 1818

Wiedemann, Eilhard. Definitionen verschiedener Wissenschaften und über diese verfasste Werke. (Beitr. zur Gesch. d. Naturw., 57). *Sitzungsber. d. physik. medizin. Gesell.*, t. 50, 1-32, Erlangen 1920. 1818

1. Im *Fihrist* von AL NADÎM (d. 995) aufgeführte Werke: 2. Definitionen nach IBN SÎNÂ; 3. Definitionen nach AKFÂNÎ (d. 1348, also called ANSÂRÎ or SACHÂWÎ); 4. Definitionen nach HÂGGÎ CHALFA (c. 1600-1658); 5. Aus der Schrift über die Wissenschaften von AL TAUHÎDÎ (fl. c. 1000). G. S.

13. — ISRAEL

Wolfson, Harry Austryn. The needs of Jewish scholarship in America. *The Menorah Journal for February* 1921, 8 p. 1818

A spirited plea for Jewish scholarship, especially the study of mediæval Jewish philosophy. « Medieval philosophy is one philosophy, written in three languages, Arabic, Hebrew and Latin, and among these, Hebrew holds the central and most important position. In it we have the full efflorescence of Arabic thought and the bud of much of scholasticism ». Yet, a great deal of this Jewish literature is still unpublished. WOLFSON suggests that American Jewry should present the Republic of Letters with a *Corpus Scriptorum Philosophicorum Hebraeorum*. We would sign this plea with both hands. G. S.

14. — JAPAN

Griffis, William Elliot. The Mikado : institution and person. A study of the internal political forces of Japan. VII + 346 p. Princeton University Press, 1915. 1818

The author spent a good part of his life in Japan as professor at the Imperial university of Tokyo. He is a fervent admirer of the late emperor MUTSUHITO. G. S.

Hara, Katsuro. An introduction to the history of Japan. XX + 411 p. New York and London, PUTNAM 1920. 1818

The first publication of the Yamato society, a Japanese organization, the object of which is to explain Japan to the Western peoples. A popular account; apparently well-informed; a little prolix. G. S.

Waley, Arthur. Japanese poetry. The « Uta », 110 p. Oxford University Press 1919. 1818

15. — MIDDLE AGES

Beazley, C. Raymond. A note-book of mediæval history. A. D. 323-A. D. 1453. VIII + 224 p. Oxford, Clarendon Press, 1917. 1818

A notebook in which the fundamental divisions are chronological, and containing fairly copious references to the history of civilization.

Crane, T.-F. Mediæval sermon-books and stories and their study since 1843. *Proc. Amer. philosoph. soc.*, t. 56, 369-402, Philadelphia 1917. 1819

Dreyer, J.-L.-E. Mediæval astronomy. *Studies in the history and method of science*, vol. II, 102-120. Oxford 1921. 1818

An extensive review of the mediæval part of PIERRE DUHEM. Le système du monde, t. I-V, 1913-1917. This review has almost the value of an original study and should be read by anyone studying DUHEM's book.

G. S.

Gleichen-Russwurm, A. von. Der Ritterspiel. Geschichte der vornehmen Welt im romanischen Mittelalter. 5 Tausend. XVI + 436 p. Stuttgart, HOFFMANN, 1918. 1818

Gleichen-Russwurm, A. von. Die Gotische Welt. Sitten und Gebräuche im späten Mittelalter. 4. Tausend. XVI + 429 p. Stuttgart, HOFFMANN, 1919. 1818

« Die Gotische Welt » is the fifth and last but one volume of the author's « Geschichte der Geselligkeit Europas ». It is divided as follows : I. Bürgertum und Absolutismus ; II. An den Quellen des Humanismus ; III. Im grossen Totentanz ; IV. Die letzten Ritter. — A subjective synthesis based upon considerable literary knowledge. G. S.

Jeanselme, E. Le vin, la vigne et l'alcoolisme dans les Gaules à l'époque de l'établissement des barbares (V^e^-X^e^ s.). *Bull. soc. franç. hist. méd.*, t. 14, 264-300. Paris 1920. 1818

Menetrier, P. L'alcoolisme cause de la dégénérescence de la race chez les rois mérovingiens. *Bull soc. franç. hist. médec.*, t. 14, 301-309. Paris 1920. 1818

Norlind, Arnold. Einige Bemerkungen über das Klima der historischen Zeit, nebst einem Verzeichnis mittelalterlicher Witterungserscheinungen. *Acta Universitatis Lundensis, nova series*, X, 55 p. Lund 1914. 1818

A very important study of climatic variations during the Middle Ages followed by a chronological summary of the main meteorological phenomena from 709 to 1499 ; with indication of sources. Follow two more special studies of the same kind : the freezing of the Baltic and the Kattegat ; SIGEBERTI *Chronographiae Continuatio Aquicinctina* (A. D. 1149-1201).

G. S.

Poole, Reginald Lane. Medieval reckonings of time (Helps for students of history, 3), 47 p. London, Society for promoting Christian knowledge, 1918. 1818

Prutz, Hans. Die Friedensidee im Mittelalter. *Sitzungsber. d. Bayer. Akad. d. Wiss., phil. Kl.*, München 1915. 42 p. 1819

Reinhardt, Hellmuth. Auszug aus der Abhandlung : Ein Tractat über Arzneiwässer, nach ihren Wirkungen zusammengestellt, aus dem Breslauer *Codex Salernitanus* zum ersten Male hrg. und mit dem Texte eines Codex [no. 1502] aus der Biblioteca angelica zu Rom verglichen. (*Diss.*, Leipzig) 22 p. Freiberg i. Sa. 1921. 1818

Contains the Latin text *de aquis medicinalibus et earum differentiis*, Breslau *codex Salernitanus*, f° 177r to 179r. No mention of alcohol, which became widely known in S. Italy c. 1160 1170. G. S.

Streeter, Edward Clark. Cultural factors influencing science in the Pre-Renaissance. *Bull. of the medical and chirurgical faculty of Maryland*, vol. 13, 2-8, Baltimore 1920. 1819

Streeter, Edward Clark. Mediæval libraries of medicine 500 A. D. to 1500 A. D. *Bulletin of the medical library association*, t. 10, 15-20. January 1921. 1819

A delightful account starting with CASSIODORUS' list (c. 535); interesting for the history of medical education. G. S.

Wickersheimer. Figures médico-astrologiques des IX^e^, X^e^ et XI^e^ siècles. *Janus*, t. 19, p. 155-177, 11 fig., Leyde 1914. 1819

1. Macrocosme et microcosme; 2. Les signes du zodiaque et le corps humain; 3. La sphère de PETOSIRIS; 4. La sphère d'APULÉE ou de PYTHAGORE; 5. Le Tétragone sujet; 6. Les trois figures du MS. lat. 17868 de la Bibl. Nation. — Toutes ces figures relèvent presque exclusivement de la tradition païenne. G. S.

16. — ROME

Guelliot, O. Les oculistes gallo-romains de Reims. *Bull. soc. hist. méd.*, t. 15, 182-188. Paris 1921. 1818

Mygind, Holger. Die Wasserversorgung Pompejis. *Janus*, t. 22, 294-351, 27 fig. Leyde 1917. 1818

Strong, Mrs. Arthur. Apotheosis and after life. Three lectures on certain phases of art and religion in the Roman empire. XX+293 p., 32 pl. New York, DUTTON, 1915. 1818

Apotheosis of the imperial figure and its influence on design; Symbolism of the after life on the gravestones of the later Roman empire; After life. — With an introductory address on Rome and the present state of Roman studies. G. S.

PART III

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Systematic Classification.

1. — ANATOMY

Cole, F.-J. The history of anatomical injections. *Studies in the history and method of science*, vol. II, 285-343, illustr. Oxford 1921. 1818

An elaborate study of this subject down to our days, but chiefly of the developments which took place in the XVIth and XVIIth cent. HARVEY'S

work (1628) was the fundamental influence in the early injection experiments. « The period of injection lies between 1650 and 1750, after which interest in injections gradually declined as it was found that the new method was unable to realize the great expectations of its professors. FREDERIK RUYSCH's activities are comprised between the dates 1665 and 1728 and hence coincide almost exactly with the middle of the injection period. The first injections, however, were not anatomical, but were undertaken for physiological or medical reasons... In 1667, and again in 1670, the French Academy conducted numerous injection experiments in the belief that the reinvigoration and even the rejuvenescence of mankind would be thereby accomplished... ». G. S.

3. ARCHÆOLOGY

Museums and Collections.

Bates, Oric [*editor*]. Harvard African studies I. Varia Africana I. VIII + 292 p., 4°, illustr. The African Department of the PEABODY Museum of Harvard University. Cambridge, Mass., 1917. 1818

The scope of this new publication may be defined as African anthropology in the widest sense. A preface to this first volume was contributed by THEODORE ROOSEVELT. G. S.

Deonna, W. L'archéologie. Ses principes, son utilité. Leçon d'ouverture du cours d'archéologie classique et orientale à l'Université de Genève, 17 janvier 1921, 16 p. Genève, SONOR, 1921. 1818

Definition and aims of archæological research briefly stated by a scholar whose ideas have already been fully analyzed in *Isis*, I, 745-754, III, 481. G. S.

4. — ART. ART and SCIENCE

Iconography.

Lavignac, Albert (*editor*). Encyclopédie de la musique. Première partie. Histoire de la musique. 2e fascicule. Italie, Allemagne, p. 611-1175. Paris, DELAGRAVE 1914. 1818

Italie (p. 611-910) : XIVe et XVe siècles par GUIDO GASPERINI; XVIe et XVIIe siècles par OSCAR CHILESOTTI; l'opéra au XVIIe siècle en Italie par ROMAIN ROLLAND; XVIIe et XVIIIe siècles par L. VILLANIS; 1725 à 1792 par M. SOFFREDINI; 1792 à 1837 par G. RADICIOTTI et A. CAMETTI (ROSSINI et son école); Période moderne par ALBERT SOUBIES; Les contemporains par GIOVANNI MAZZONI.

Allemagne : Les origines de l'opéra (XVIIe siècle) par ROMAIN ROLLAND; La musique religieuse depuis les Psaumes de SCHÜTZ 1619 jusqu'à la mort de BACH 1750 par ANDRÉ PIRRO; Les grands classiques (XVIIIe siècle) par MICHEL BRENET; Le romantisme, 1815 à 1837 par P.-H. RAYMOND-DUVAL; Période contemporaine par CAMILLE LE SENNE (presque exclusivement consacré à WAGNER).

Le texte contient de nombreux exemples musicaux. G. S.

Means, Philip Ainsworth. A survey of ancient Peruvian art *Transactions of the Conn. academy of arts and sciences*, vol. 21, 315-442, 17 pl. New Haven 1917. 1818

The main purpose of the author is to establish a basis for the classification of pre-Columbian Peruvian art objects; therefore his study is confined « to those regions where the form and stratigraphic relations of the various art-types that make up the sequence of cultures have been determined with a reasonable degree of precision ». See p. 393 a « table to show roughly the chronological order of the early Peruvian culture periods ». The cultures follow one another in this order : 1. Proto-Chimu, Proto-Nasca, Tiahuanaco I; 2. Tiahuanaco II; 3. « Epigonal » and Red-white-black; 4. Chimu and Nasca, Colla-Chulpa, Early Inca; 5. Inca Empire. G. S.

Schlosser, Julius von. Materialien zur Quellenkunde der Kunstgeschichte. Heft 1-3. *Wien, Akademie d. Wiss., Philos.-hist. klasse, Sitzungsber.*, t. 177, 179, 180, 1914-1916. 1818

I. Heft. *Mittelalter* (t. 177, 1914, 102 p.) : Ueber Begriff und Umfang der Kunsthistorischen Quellenkunde; 1. Beginn. der abendländischen Kunstlit.; 2. Die mittelalterl. Kunstlit.; 3. Zur Kunsttheorie des Mittelalters; 4. Theorie und Praxis im toskanischen Trecento.

II. Heft. *Frührenaissance* (t. 179, 1915, 72 p.) : 1. Die historische Lit.; 2. Die Theoretiker; 3. Die historischen Thesen; 4. Die kunsthistor. Thesen.

III. Heft. *1. Hälfte des Cinquecento* (t. 180, 1916, 76 p.) : 1. Leonardos Vermächtnis; 2. Kunsthistoriographie; 3. Kunsttopographie; Beginn der Guiden lit. (This critical bibliography is also of interest for the history of arts, of perspective, of technology). G. S.

6. — ASTRONOMY, GEODESY, METEOROLOGY and TERRESTRIAL PHYSICS

Arrhenius, Svante. Le Destin des Étoiles. Études d'astronomie physique Traduction française par T. Seyrig (*Nouvelle collection scientifique*) v + 218 p., 31 fig. Paris, Alcan, 1921. [fr. 8]. 1818

Cet ouvrage, dont la première édition suédoise parut en 1915 ou 1916, fait suite aux deux livres d'Arrhenius intitulés : l'*Evolution des Mondes* et *la Vie de l'Univers*. On y retrouve les mêmes larges vues synthétiques appuyées sur une connaissance précise et profonde de tous les faits pertinents. Les sujets suivants sont étudiés : L'énigme de la voie lactée; Influence de la vapeur d'eau sur les climats (critique des théories d'Huntington); Atmosphère et constitution des corps stellaires; Planète Mars; Mercure, la Lune et Vénus; Origines du culte des étoiles (conférence, Bologne 1911). S. Arrhenius a mis à jour certaines parties de la traduction française. Les illustrations sont les mêmes que celles de l'édition anglaise, sauf que l'une d'elles qui n'était point exacte, a été remplacée. G. S.

Bigourdan, G. [Various notes on French astronomy]. *Comptes rendus de l'Académie des Sciences*, t. 166-167, Paris 1918. 1818

I do not quote these notes individually for they are merely of local interest and will be reprinted in book form. G. S.

Collard, Auguste. L'astronomie et les astronomes. (Répertoire des ouvrages à consulter. Collection créée pour l'avancement des sciences, des lettres et des arts en Belgique). VIII + 120 p. Bruxelles, VAN OEST, 1921. 1818

Une liste de 758 titres complétant l'admirable bibliographie de HOUZEAU et LANCASTER. La plupart des ouvrages mentionnés ont donc paru depuis 1880. Les titres sont classés comme suit : dictionnaires et encyclopédies d'astronomie; biographies d'astronomes (celle de SIMON NEWCOMB n'est pas citée); traités d'astronomie (généraux et spéciaux); histoires; bibliographies; atlas; revues; tables. Cette liste sera utile quoique ce ne soit pas du tout une bibliographie synthétique (*Isis* III, 159) et que les notes critiques soient très rares et insuffisantes. G. S.

Dannemann, Friedrich. Wie unser Weltbild entstand. Die Entwicklung der Vorstellungen über den Bau des Kosmos von den Anfängen bis zur EINSTEIN'SCHEN Relativitätstheorie. 18. Aufl. 80 p. Stuttgart, Kosmos, 1921. 1818

A popular and well illustrated account of the development of astronomy by the well-known author of « Die Naturwissenschaften in ihrer Entwicklung ». G. S.

Ginzel, F.-K. Beiträge zur Kenntnis der historischen Sonnenfinsternisse und zur Frage ihrer Verwendbarkeit. *Abhdl. d. kgl. preuss. Akad. d. Wiss.*, J. 1918, *Physik. mathemat. Kl.*, Nr. 4, 43 p., 2 pl. Berlin 1918. 1818

Series of studies devoted to the following solar eclipses (total or annular) : 693 (1030), 1033, 1113 (1131), 1133, 1147, 1187 (1194), (1236), 1239, 1241, (1263), (1312), 1330 (1337), 1339, 1361. (I have written between brackets those not included in the second list). List of ancient eclipses : —1062, —762, —647, —584, —556, —477, —430, —399, —309, —128, +71, +197, +418 Medieval eclipses (only the utilizable ones quoted) : 483, 590, 693, 733, 840, 878, 891, 939, 968, 1033, 1113, 1133, 1147, 1187, 1191, 1239, 1241, 1267, 1330, 1339, 1361. G. S.

Günther, Siegmund. Die indirekten Ortsbestimmungsmethoden in der Entwicklung der mathematischen Geographie. *Sitzungsber d. math. physik. Klasse d. Bayer. Akad. d. Wiss.*, 1919, 299-351. 1818

By *indirect* method GÜNTHER means when the reading is not made on a circle but on a straight line, thus necessitating the calculation of the corresponding angle. 1. Dreistab und geometrisches Quadrat; 2. Der Grundgedanke des JAKOBSstabes; 3. LEVI BEN GERSCHOM und REGIOMONTANUS; 4. Der JACOBSstab im Entdeckungszeitalter; 5. Das 16., 17. und 18 Jahrh. G. S.

Schück, Albert (Brieg, Silesia, 1833-Hamburg, 1918). Der Kompass. 3 Bde., f°. Selbstverlag des Verfassers. Hamburg 1911-1918. Druck von EMIL KORFF, Deichstrasse 49. 1818

Vol. I, 1911 contains 46 plates with explanations (17 p.) retracing graphically the whole evolution of the compass from the early Chinese origins down to c. 1909.

Vol. II, 1915, plates 47 to 79 (Sagen von der Erfindung des Kompasses. Magnet, Calamita, Bussole. Kompass. Die Vorgänger des Kompasses).

Vol. III, 1918, plates 80-88 (Nachtrag zu II. Armierte Magnetsteine (natürliche Magnete) mit verzierter Fassung.

This work of fundamental importance should be completed by an index. The author was a captain in the German navy (see obituary notice by FELDHAUS in *Geschichtsblätter für Technik*, vol. VI, 218). G. S

Stimson, Dorothy. The gradual acceptance of the Copernican theory of the universe. 147 p., 3 pl. New York, The BAKER and TAYLOR Co., 354 Fourth Avenue, New York 1917. 1818

A study in the history of thought. 1. Historical sketch of the heliocentric theory; 2. Reception of the Copernican theory : opinions and arguments in the XVIth cent.; BRUNO and GALILEO; gradual acceptance of the theory; the church and the new astronomy.

Appendices : translation from the *Almagest*; *de revolutionibus* (dedication to the Pope); BODIN and FIENUS. G. S.

7. — BIBLIOGRAPHY and LIBRARIES

Jacobs, Katharine. A list of American doctoral dissertations printed in 1918. 200 p. (Library of Congress). Washington, Government printing office 1921. 1818

A list of the 360 doctoral dissertations published in the U. S. in 1918. The full titles are given in alphabetical order, then again classified by subject. Each title is thus quoted fully twice. This seems a sheer extravagance. A list of 360 titles without criticism of any kind should not fill 200 pages (that is less than 2 titles per page!). A classification of the doctors by universities is interesting. I would suggest the addition of a few statistical summaries. G. S.

8. — BIOLOGY

Hagedoorn, Arend L. and **Hagedoorn-Vorstheuvel La Brand, A.-C.** The relative value of the processes causing evolution. 294 p., with 20 fig. The Hague, MARTINUS NIJHOFF, 1921. 1819

The authors have been much struck by the fact that each theorician of evolution, excepting DARWIN, has always over-emphasized one point, one single link in the chain of processes which goes to the making of species, and has brought out his point as « the » cause of evolution. This one-sidedness has been aggravated by the fact that most geneticians were either zoölogists (like WEISMANN) or botanists (like de VRIES). After DARWIN, no one has set forth a comprehensive theory of evolution worth the name. The authors have tried to emulate him, taking into account all the new knowledge available. Their outline is divided as follows : Heredity; Variation; Crossing; Reduction of variability; Mutation; Selection; Species and varieties; Law of JOHANNSEN; Evolution in nature and under domestication; Status of man; Bibliography. The law of JOHANNSEN as formulated by the authors is this : the nature of the genes does not admit of qualitative variation (1915). G. S.

Haldane, John Scott. Mechanism, life and personality. An examination of the mechanistic theory of life and mind. Second edition, VII + 152 p. London, MURRAY, 1921 (first, ed., 1914). 1819

Singer, Charles, Greek biology and its relation to the rise of modern biology. *Studies in the history and method of science*, vol. II, 1-101, Oxford, 1921. 1818

Reviewed in *Isis*, IV, 380 (SARTON).

9. — BOTANY.

Arber, E-A. Newell [c. 1871-1918]. A sketch of the history of palæobotany with special reference to the fossil flora of the British coal measures. *Studies in the history of science*, vol. II, 472-89, illustr. Oxford, 1921. 1818

Introduction. The pre-scientific period (Italian renaissance; EDWARD LLHUYD. *Lithophylacii Britannici ichnographia*, 1699; JOHN WOODWARD. A catalogue of English fossils, 1728-1729; etc.). Transition to the scientific period (E.-F. VON SCHLOTHEIM. *Beschreibung merkwürdiger Kräuter-Abdrücke und Pflanzen-Versteinerungen*, 1804; *Petrefactenkunde*, 1820; WILLIAM MARTIN. *Petrificata Derbiensia*, 1809; JAMES PARKINSON. *Organic remains of a former world*, 1804.

Scientific period : I. Pioneer stage, 1818-1870; II. Early scientific study of petrifications; III. Intermediate period in the study of incrustations; IV. Modern period, from about 1870. — Reproductions of ancient palæobotanical images illustrate beautifully this important memoir. G. S.

Buller, A.-H. Reginald. Essays on wheat, including the discovery and introduction of marquis wheat, the early history of wheat-growing in western Canada, the origin of red bobs and kitchener and the wild wheat of Palestine. xv + 340 p., 50 illustr. New York, MACMILLAN, 1919. 1818

Leclerc, Henri. Histoire de l'ail. *Janus*, t. 23, 167-191, Leyde, 1918. 1818

Leclerc, Henri, Histoire du lierre. *Bull. soc. hist. méd.*, t. 15, 17-37. Paris, 1921.

10. — CHEMISTRY.

Backer, H.-J. Oude chemische werktuigen en laboratoria van ZOSIMOS tot BOERHAAVE. 68 bdz., 51 abd., Groningen, WOLTERS, 1918 [fl. 1. 90]. 1818

A very interesting and well illustrated study of chemical instruments from the days of Alexandrian alchemy to BOERHAAVE, which originated in a series of lectures organized to celebrate the opening of the new laboratory for organic chemistry at the University of Groningen. The author deals first with the *Instruments*, considering successively digesters; apparatus for distillation and filtration; crucibles; ovens; lute, etc.; then with the *Laboratoria*; the oldest labor; the alchemical labor. of the XVIth and XVIIth cent.; the first scientific labor. in the XVIIth cent., for ex. LIBAVIUS' plan of 1606. G. S.

Bein, Willy. Das Stein der Weisen und die Kunst Gold zu machen. Irrtum und Erkenntnis in der Wandlung der Elemente, mitgeteilt nach den Quellen der Vergangenheit und Gegenwart. 174 S. mit 10 Abbild. (*Voigtländers Quellenbücher*, 88) Leipzig, VOIGTLÄNDER, 1915. 1818

An anthology of alchemy from the earliest times to our days. G. S.

Chemical Society. Annual reports of the progress of chemistry for 1920. Vol. 17. x + 264 p. London, GURNEY and JACKSON, 1921. 1818

Lippmann, O. von. Noch einmal « Caput mortuum ». *Chemiker-Zeitung.* 1921, nr 100. (reprint, 3 p.). 1818

The red iron oxide was often called *Caput mortuum* and *colcothar*. The origin of the first phrase is Egyptian-Greek; of the second, Greek-Syriac.
G. S.

Moureu, Charles. La chimie et la guerre. Science et avenir (Les leçons de la guerre). III + 384 p. Paris, MASSON, 1920. 1818

11. — ECONOMICS.

Broodbank, Sir **Joseph-G.** History of the Port of London. In two vol. illustr. London, Daniel O'Connor, 1921. 1818

Sir JOSEPH has written this history from the earliest days down to our own but he does not claim any special authority for the period preceding the XVIIIth cent. On the other hand in writing the later chapters he has had the advantage of access to Port records of the last 120 years, supplemented by 49 years' association with Port administration. Historians and economists will find it profitable to compare the advantages of the various forms of control which have prevailed in the Port during past centuries. These books are richly illustrated with reproductions of old prints (some in colour), portraits, maps, etc. G. S.

12. — EDUCATION.

Bruxelles. Université internationale L'université internationale. Documents relatifs à sa constitution. Rapport. Conférence. Statut. Session inaugurale. 146 p. Bruxelles, Palais mondial 1920. 1818

Herzog M.-A. Sind den Fachlehrern für Naturwissenschaften altsprachliche Kenntnisse vonnöten? Mit einem sczialistischen Nachwort und einem Anhang : 1. Der Philosoph ARISTOTELES in den Quellenschriften zur Geschichte der Erziehungslehre; 2. Aufbau und Ausbau des grossstädtischen Schulwesens (Basels). 120 p., 1 pl. Basel, 1921. 1818

Watson, Foster (*editor*) An encyclopædia and dictionary of education. Part I. LONDON, PITMAN, 1921. 1818

13. — ETHNOLOGY. PRIMITIVE and POPULAR SCIENCE.

Adriani, N. Schwangerschaft und Geburt bei den Toradja in Mittel-Celebes. *Janus*, t. 23, 108-117. Leyde, 1918. 1818

Günther, Siegmund. Ethnologisch-Mathematisches. *Sitzungsber. d. bayer. Akad. d. Wiss., math. phys. Klasse*, München 1917, 111-125. 1818

General reflexions on ethnological theories (convergence vs. derivation) with special reference to two independent position systems with zero, the decimal system of the Hindoos and the vigesimal system of the Mayas.
G. S.

Hartland, Edwin Sidney Primitive society. The beginnings of the family and the reckoning of descent. 180 p. London, METHUEN, 1921. 1818

Hough, Walter. Man and metals. *Proceedings of the National Acad. of sciences*, vol. II, 123-9, Washington, 1916. ISIS

A summary of HOUGH'S long studies on the subject. The first free metals discovered by man were copper, gold and silver. Later he acquired by heat, tin and iron. G. S.

Kleiweg de Zwaan, J.-P. Kleidung und Krankheiten. Ethnologische und historische Betrachtungen. *Janus*, t. 21, 63-110, Leyde, 1916 ISIS

Kreemer J. jun. Volksheilkunde im malaiischen Archipel. *Janus*, t. 20, 47-71, 113-142, 202-231, 365-408, Leyde, 1915. ISIS

Nilsson, Martin P. Primitive time reckoning. (*Acta societatis humaniorum litterarum Lundensis*, I). XIII + 384 p. Lund, GLEERUP, 1920. ISIS

An exhaustive study of the subject divided as follows: Day; seasons; year; stars; month; months; old Semitic months; calendar regulation (intercalation, beginning of the year); popular months of the European peoples; solstices and equinoxes, aids to the determination of time; artificial periods of time, feasts; calendar-makers; conclusion. The substance of the book was ready in the spring of 1917. The author was not able to include the additional material gathered by H. WEBSTER in his Rest Days, New York, 1916, but this material would not affect his conclusions.

Stevenson, Matilda Coxe. Ethnobotany of the Zuñi Indians. *Thirtieth annual report of the Bureau of American ethnology*, 1908-1909, p. 31-102. Washington, 1915.

Medical practice and medicinal plants. Edible plants. Use of plants in weaving, in dyeing, in basketry, in pottery decoration, for the toilet, in folk-lore. Clan names and other names derived from plants. Ceremonial uses of plants. List of plants. G. S.

14. — GEOGRAPHY.

Endrös, A. Zum Problem des Euripus. *Sitzungsber. d. bayer. Ak. d. Wiss., math. physik. Kl.*, München, 1914, 99-139.

A scientific study of the irregular currents taking place between the isle of Euboea and the Greek mainland; a very old oceanographical problem. For ARISTOTLE'S views on the subject, see *Isis*, IV, 395. G. S.

Norlind, Arnold. Das Problem des gegenseitigen Verhältnisses von Land und Wasser und seine Behandlung im Mittelalter. *Acta Universitatis Lundensis, nova series*, XIV : 1, 57 p. Lund 1918. ISIS

The ocean problem in ancient times, in patristic times. Moslem geography. The problem in later mediæval times. For a later development of the same problem (first attempt to measure the ratio of the areas of land and sea by AL. PICCOLOMINI (1557) see *Isis* IV, 141, under ALMAGIÀ. G. S.

Ruge, W. Aelteres kartographisches Material in deutschen Bibliotheken. Fünfter Bericht über die Jahre 1910—1913. *Nachrichten der Kgl. Ges. d. Wiss. zu Göttingen, philol.-histor. Kl.*, 1916 Beiheft 128 p. ISIS

The first report appeared *ibidem* in 1904. G. S.

Wensinck, A.-J. The ideas of the Western Semites concerning the navel of the earth. *Verhand. d. k. Ak. van Wetenschappen, Afdeeling Letterkunde*, t. 17, XII + 65 p. Amsterdam 1917. 1818

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The ocean in cosmogony. The ocean in cosmography (under the earth, above the earth). Character of the ocean. G. S.

Young, Geoffrey Winthrop (*editor*). Mountain craft. XVIII + 603 p., ill., London, METHUEN, 1920. 1818

15. — GEOLOGY, MINERALOGY, PALÆONTOLOGY, MINING

(for palæobotany and palæozoology, see respectively botany and zoology).

Gregory, J.-W. National contributions to Geology. (*Scientia*, XXX, 1er juillet 1921, 1-12; traduct. française : Supplément, 1-12). 1818

1) The recognition and use of fossils; 2) systematic paleontologie; 3) fossils and evolution; 4) geological cartography; 5) the stratigraphical classification; 6) mineralogy; 7) petrology; 8) metamorphic rocks; 9) tectonic and structural geology.

La traduction française est faite sans soin. L. G.

Haug, Emile Les disciplines de la geologie. *Revue générale des sciences*, t. 101-111, 165-175, 229-238. Paris 1921. 1818

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Holmes, Arthur. The nomenclature of petrology, with references to selected literature. 284 p. London, MURBY, 1920.

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Schuchert, Charles. Atlantis and the permanency of the North Atlantic Ocean. *Proc. of the Nat. Ac. of Sci.*, t. 3, 65-72. Washington 1917. 1818

A reply to TERMIER's paper (*Isis* III, 135), concluding « that there are no known geologic data that prove or even help to prove the existence of PLATO's Atlantis in historic times ». G. S.

16. — HISTORY of CIVILIZATION. GENERAL HISTORY. HISTORICAL METHODS. BIOGRAPHY and CHRONOLOGY.

Cabanès, Auguste. Fous couronnés. 439 p., 56 illustr. Paris, ALBIN MICHEL [1914]. 1818

Biographies médicales de JEANNE LA FOLLE, PHILIPPE II d'Espagne, PIERRE

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Biographies médicales de JEANNE LA FOLLE, PHILIPPE II d'Espagne, PIERRE

LE GRAND, PIERRE III, PAUL I de Russie, CHRISTIAN VII de Danemark, OTHON et LOUIS II de Bavière. G. S.

Croce, Benedetto. Theory and history of historiography. Translated from the Italian by DOUGLAS AINSLIE. 317 p. London, HARRAP, 1921. [15 s.] ISIS

This is the fourth and last volume of the *Philosophy of the Spirit*, of which it forms the conclusion. The three first volumes were respectively entitled : Logic; Philosophy of the Practical; Æsthetic. The translation of vol. IV is made from the 2nd Italian ed., 1919. It is divided into two parts: Theory of historiography ; Concerning the history of historiography. The second part is of greater interest to us, though I must admit that it is almost as repellent to me as the rest of CROCE's philosophy. It will probably appeal more to people who are more metaphysically minded than I. As to myself, I can hardly read it, for the diffuseness, prolixity, obscurity and confusion of this book irritate me to a degree. It is neither philosophy nor history ; neither fiction nor truth. Take it away ! G. S.

Stoddard, Lothrop. The rising tide of color against white world-supremacy. With an introduction by MADISON GRANT, XXXII + 320 p. New York, SCRIBNER, 1920. ISIS

A very clear and forcible summary of universal history from the racial point of view. The author shows the dangers of race mixture and urges that Asia be given back to the Asiatics and the domains inhabited by the white race closed to them. The Great War has been essentially a civil war of the white race. G. S.

19. — MATHEMATICS.

Lecat, Maurice. Bibliographie des Séries Trigonométriques, avec un appendice sur le Calcul des Variations. 169 p. Chez l'auteur, Avenue du Bois de la Cambre, 16, Bruxelles 1921. ISIS

L'auteur bien connu par ses recherches sur les déterminants à n dimensions, nous offre ici une abondante bibliographie des séries trigonométriques par ordre alphabétique des noms d'auteurs. Il y a en tout 2560 travaux, dont 935 en français, 765 en allemand, 495 en anglais, 110 en latin, 100 en italien, etc. Des 1000 auteurs cités, 268 sont Allemands, 158 Français, 135 Anglais, 65 Italiens, etc. Une classification de ces mémoires par sujets, et une classification chronologique eussent été fort utiles. Une bibliopraphie du calcul des variations terminant cet ouvrage, complète la bibliographie publiée par l'auteur en 1913-1916. LECAT est l'auteur français du fasc. de l'*Encyclopédie des sciences mathématiques* relatif au Calcul des Variations, 288 p. 1913-1916. Il avait préparé le texte français du fasc. relatif aux Séries trigonométriques (env. 900 p.), mais ce texte ne verra probablement jamais le jour, l'Encyclopédie ayant été tuée par la « Conférence interalliée des académies scientifiques », — une belle œuvre de chauvinisme obscurantiste ! (voir *Isis* IV, 39). G. S.

Loria, Gino. Les contributions des différents peuples au développement des mathématiques. 1re partie : Evénements mémorables et hommes représentatifs dans l'histoire des mathématiques. 2me partie : Le caractère international de la pensée mathématique. [*Scientia*, XXIX, 1er mars et 1er avril 1921, 169-184, 235-262]. ISIS

La conclusion de ce mémoire est un appel à une concorde joyeuse et vraiment internationale entre les mathématiciens : « ne nous efforçons pas d'élever des barrières où tout conseille de construire des ponts ». L. G.

Smith, David-E. Ten great epochs in the history of mathematics [*Scientia*, XXIX, 1er juin 1921; 417-429; traduct. française; supplément, 79-89.] 1818

Bref aperçu du développement général des mathématiques, partagé en dix périodes qui débordent nécessairement les unes sur les autres, n'ont ni commencement, ni fin définis. 1° Epoque de l'intuition; 2° Epoque de la déduction: THALÈS, PYTHAGORE, PLATON; 3° Epoque de l'exposition: EUCLIDE, APOLLONIUS, DIOPHANTE; 4° Epoque de l'application: ARCHIMÈDE, ERATOSTHÈNE, HIPPARQUE, HÉRON, PTOLÉMÉE; 5° Epoque du symbolisme numérique: introduction du système des chiffres actuellement employés; 6° Epoque de la poésie, du VIIme au XIIme s. dans l'Inde; 7° Epoque de la transmission: traductions latines des Grecs d'après les traductions arabes; 8° Epoque du symbolisme: VIÈTE, DESCARTES, OUGHTRED; 9° Epoque de la géométrie supérieure, que l'on peut faire commencer à DESARGUES, et qui est naturellement encore ouverte, ainsi que 10° Epoque de l'analyse supérieure, préparée par les EUDOXE, PYTHAGORE, ARCHIMÈDE, etc., et qui commence vraiment au début du XVIIme s. avec FERMAT et DESCARTES.

L. G.

Soreau, Rodolphe. Sur l'origine et les sens du mot « abaque ». *Comptes Rendus de l'Académie des Sciences*, t. 166, p. 67-69. Paris 1918. 1818

L'origine est le mot ἄβαξ qui signifie tablette. Ce mot grec désignait un simple tableau alphabétique des nombres. Comparaison des termes abaque et nomogramme. G. S.

Tropfke, Johannes. Geschichte der Elementar-Mathematik in systematischer Darstellung mit besonderer Berücksichtigung der Fachwörter. Erster Band. Rechnen. 2te verbesserte und sehr vermehrte Auflage. VIII + 177 p. Berlin, Vereinigung wissenschaftl. Verleger 1921. [M. 131.50] 1818

A. Die Zahlen im allgemeinen; B. Die Masse; C. Die ganzen Zahlen; D. Die Brüche; E. Angewandte Rechnen. G. S.

Vetter, Quido. La storia della matematica presso i Cechi. *Archivio di storia della scienza*, vol. II, 199-201. Roma 1921. 1818

A short review of Bohemian work on the history of mathematics. G. S.

20. — MECHANICS

Poor, Charles Lane. The motions of the planets and the relativity theory. *Science*, vol. 54, 30-34, 1921. 1818

Vollgraff, J.-A. CHRISTIAAN HUYGENS (1629-1695) et JEAN LE ROND D'ALEMBERT (1715-1783). *Janus*, t. 20, 269-313. Leyde 1915. 1818

21. — MEDICINE

A. — *History. Organization and Philosophy.*

Cyriax, Richard J. A short history of mechano-therapeutics in Europe until the time of Ling. *Janus*, t. 19, 178-240. Leyde 1914. 1818

Ancient Greece;—Roman empire until VIIth cent.; 700-1600; XVIIth cent.; 1700-1750; 1750-1813. The account stops at the year 1813, in which

the Royal Central Gymnastic Institute was founded at Stockholm with P. H. LING at its head. CYRIAX is satisfied that before LING's innovations, medical gymnastics with but few exceptions (*ex. gr.* QUELLMALZ' abdominal frictions, 1735) had made no substantial advance since the time of GALEN, ARETAEUS and PAULUS ÆGINETA. G. S.

Feyfer, F.-M.-G. De. Zur Geschichte des Schamfugenschnittes in Holland (bis 1840). *Janus*, t. 19, 312-327, 341-379. Leyde 1914. 1818

Foote, John. Ancient poems on infant hygiene. *Annals of medical history*, t. II, 213-227. New York 1919. 1818

Fosseyeux, Marcel. Les aliénés à Paris. *Communication faite au premier congrès de l'art de guérir.* 11 p. Anvers 1921. 1818

Ces notes sur l'hospitalisation des aliénés à Paris sous l'ancien régime se rapportent surtout aux XVII^e^ et XVIII^e^ siècles. G. S.

Janet, Pierre. Les médicamentations psychologiques. Études historiques, psychologiques et cliniques sur les méthodes de la psychothérapie, 3 vol., 346 + 308 + 494 p. Paris, ALCAN, 1919. 1818

I. L'action morale, l'utilisation de l'automatisme; II. Les économies psychologiques; III. Les acquisitions psychologiques.

Johnsson, J.-W.-S. Landfahrer in Dänemark. *Janus*, t. 20, 235-268. Leyde 1915. 1818

Includes a list of itinerant foreign doctors and quacks in Denmark, the successors of the Salernitan *circumforanei*, most of them of the XVIIth and XVIIIth cent. Important contribution to the study of medical practice in Denmark. G. S.

Johnsson, J.-W.-S. Folkemedicinske undersögelser. *Danske Studier*, 1921, 20 p., 1 pl. Copenhagen. 1818

Three investigations on folk medicine: 1. On some jugs made of *Terra sigillata*, though not of the real one, and kept in the Danish National Museum (to appear later in French); 2. On the *healing step* practised by the howling dervishes in Scutari, an old medical superstition which the author traces as far back as the palæolithic fragment called « la femme au renne »; 3. On a singular cure of *incontinentia urinae* (running naked through a church up to the altar, etc). G. S.

Lützhöft, Fr. Ein Abschnitt aus der Geschichte des Kindbettfiebers. *Janus*, t 22, 357-371. Leyde 1917. 1818

[Medicine, history. Italy]. Un istituto storico dell' arte sanitaria italiana. *Archivio di storia della scienza*,, vol. II, 291-293, Roma 1921. 1818

Apropos of the recent foundation of this Institute for the History of Medicine in Rome. The Institute will be located in the Hospital Santo Spirito (in the part rebuilt by SIXTUS IV) President, MARIANO BORGATTI; secretary, PIETRO CAPPARONI. A bulletin will be published; a museum organized; lectures delivered, etc. G. S.

Parker, G. The early history of surgery in Great Britain Its organization and development. (COMRIE'S *Medical History Manuals*). x + 204 p., 8 pl. London, BLACK, 1920. 1818

« Early » in the title means down to 1850! — This popular account is

divided into 6 parts: 1000 to 1300; 1300 to 1500; 1500 to 1600; 1600 to 1700; 1700 to 1800; 1800 to 1850. The two first parts — down to 1500 — cover only 67 p.! There is a bibliography at the end, purely English, and a brief chronology ranging from 850 to 1858. G. S.

Pergens, Ed (-1917). Optotypes. *Janus*, t. 22, 406-413. Leyde 1917. 1818

Trad. franç. de la notice relative à sa collection d'optotypes exposée à Leyde en 1907. PERGENS possédait peut-être la plus riche collection d'optotypes qui ait jamais été rassemblée. Les vrais optotypes ne datent que du XIX^e^ siècle (1810, FISHER et GERSON; 1816, TAUBER; 1825, PERKINJE, etc.) mais leur préhistoire commence déjà en 1623 avec DACA DE VALDEZ. G. S.

Pino y Roca, J. Gabriel. Breves apuntes para la historia de la medicina y suo progresos en Guayaquil. 75 p. Guayaquil. Imp. y Papeleria Sucre, 1915. 1818

This interesting little volume — the first, to my knowledge, to be devoted to the history of medicine in Ecuador — was published very opportunely at the eve of the first meeting of the « Congreso Médico Ecuatoriano ». It retraces the progress of medicine in Guayaquil from the arrival of PIZARRO in 1530 to 1822, that is, during the whole colonial period. I hope that señor don GABRIEL PINO Y ROCA may soon publish the second part of this history, from 1822 to 1915. No index. G. S.

Rambaud, Pierre. L'enseignement de la chirurgie à Poitiers avant le XIX^e^ siècle *Janus*, t. 21, 182 195, 2 illustr. Leyde 1916. 1818

Ruhräh, John. A bibliography of pediatrics. *Bull. of the medical library association*, t. 10, p. 21-24. Jan. 1921. 1818

Saintyves, P L'art de guérir est-il d'origine empirique? *Janus*, t. 22, 372-390. Leyde 1917; t. 23, 56-76, 1918. 1818

[**Spain, Catalonia**] Bibliografia medical di Catalunya. Inventari primer. Près dels llibres antics i moderns presentats en l'exposició bibliográfica anexa al segon congrés de metges de llengua catalana celebrat a Barcelona del 24 al 28 de Juny de 1917. Cedulari posat en ordre alfabètic d'autors, entitats i noms geogràfics. 4°, XXXII + 478 p. 8 pl. Barcelona, 1918. 1818

Contains 2620 items arranged alphabetically by authors. G. S.

Sudhoff, Karl. Medizinische Bibliotheken. Eine historische Plauderei. 8 p. Leipzig, GUSTAV FOCK, 1921. 1818

A spirited sketch taking the reader from the earliest days of Mesopotamia and Egypt to our own. The Library of SUDHOFF's « Institut » contains now about 15,000 volumes. G. S.

Torkomian, Vahram. Les Arméniennes dans l'histoire de la médecine. *Bull. soc. hist. méd.*, t. 15, p. 38-44, Paris 1921. 1818

La première Arménienne citée s'appelait AGHVIDA (AGHAVITHI): elle était d'origine grecque et mariée au prince arménien SOURÈNE SALAHOUNY; elle a fondé vers 260-270 la première léproserie (à Arbénoud, Arménie). G. S.

Weindler, F. Der Kaiserschnitt nach den ältesten Überlieferungen unter zugrundelegen von 18 Geburtsdarstellungen. *Janus*, t. 20, p. 1-40, 9 pl. Leyde 1915. 1818

Wood, C. A. and **Garrison, F. H.** A physician's anthology of English and American poetry. XXIII + 346 p. Oxford University Press, 1920. 1819

B. — *Epidemiology. History and geography of disease.*

Andel, M. A. van. Plague regulations in the Netherlands. *Janus*, t. 21, 410-444, 4 ill. Leyde 1916. 1818

Barbézieux, G. Contribution à l'étude de l'histoire de la lèpre. La lèpre dans la plus haute antiquité. *Janus*, t. 19, p. 132-149. Leyde 1914. 1818

Cleu, Hubert. Les maladies épidémiques et contagieuses en Lorraine du IX^e^ au XIX^e^ siècle. *Bull. soc. franç. hist. méd.*, t. 13, 236-249, 1914. 1818

Lint, J. G. de. Les léproseries d'Amsterdam. *Bull. soc. hist. méd.*, t. 15, 107-114. Paris 1921. 1818

Schwarz, Ignaz. Bibliotheca Venereologica. Geschichte und Literatur der venerischen Krankheiten. 15., bezw. 16. bis 20. Jahrhundert. 106 S., 2184 Nr. Antiquariat Katalog Nr. 4. Wien, I. Habsburgergasse, 3. [1920?]. 1818

Streeter, Edward C. Exhibit of medical texts illustrating practice in fevers, plague, etc. 44 p. Boston Public Library 1921. 1818

Interesting catalogue of an exhibition organized in June by Dr. STREETER for the annual session of the American medical association — 161 items, mostly from Streeter's own library, some loaned by the Boston medical library. Its purpose was to illustrate the history of the specific infections and epidemic diseases from HIPPOCRATES to SYDENHAM. The catalogue contains much valuable bibliographic information. The order is chronological, with digressions on Plague, Syphilis and Venesection. G. S.

22 — MORALS

Robertson, John Mackinnon. A short history of morals. VII + 460 p London. WATTS, 1920. 1818

23. — PHARMACY and PHARMACOLOGY

Leclerc, Henri. Les sternutatoires à travers les âges. *Janus*, t. 21, 254-262. Leyde 1916. 1818

Leclerc, Henri. Histoire des ellébores et de l'elléborisme. *Janus*, t. 22, 223-238 Leyde 1917. 1818

Meyerhof, M. Histoire du chichm, remède ophtalmique des Égyptiens. *Janus*, t. 19, 261-288. Leyde 1914. 1818

Les Égyptiens modernes appellent *chichm* toute espèce de collyre sec blanc en poudre; mais le mot désigne surtout un collyre fait à l'aide des graines de *Cassia absus* L. Ce collyre sec n'a guère de valeur curative. MEYERHOF s'efforce d'établir son origine. G. S.

24. — PHILOSOPHY, HISTORY OF PHILOSOPHY

Brulez, Lucien. Het Vrijheidsbegrip. XVI + 239 bdz. 's Gravenhage, MARTINUS NIJHOFF, 1920. 1818

The substance of lectures delivered by the author, a *Belgian*, at the *German* university of Ghent, during the war, on the notion of freedom! It is divided as follows : Problem of free will. Principle of substantiality and formal determinism, — and real determinism; principle of causality; occasionalism; nature of fate; Kantian notion of freedom; contemporary French philosophy; principle of finality. G. S.

Merz, John Theodore. A fragment of the human mind. XIV + 309 p. Edinburgh, BLACKWOOD, 1919. 1818

A sort of supplement to the « History of European thought in the nineteenth century », answering various objections made to it. G. S.

25. — PHYSICS

Bragg, Sir William. The world of sound. Six lectures delivered before a juvenile auditory at the Royal Institution, Christmas, 1919. VIII + 196 p. London, BELL, 1920. 1818

Michaud, Félix. Énergétique générale. VII + 229 p. Paris, GAUTHIER-VILLARS, 1921. 1818

Rey, A. La contribution que les divers pays ont donnée aux progrès de la physique. Première partie : Physique Newtonnienne et physique de FRESNEL MAXWELL CLAUSIUS. Deuxième partie : Physique énergétique et physique électronique. [*Scientia*, XXIX, 1er mai et le 1er juin 1921 ; 345-360 ; 429-442]. L. G. 1818

Singer, Charles. Steps leading to the invention of the first optical apparatus. *Studies in the history of science*, vol. II, 385-413, 533-534. Oxford 1921. 1818

A very clear summary of the whole history : 1. Pre-Euclidean ; 2. EUCLID ; 3. CLEOMEDES ; 4. RUFUS of EPHESUS ; 5. HERO of ALEXANDRIA ; 6. PTOLEMY ; 7. ALHAZEN ; 8. AVICENNA ; 9. WITELO ; 10. R. BACON ; 11. PECKHAM ; 12. Invention of spectacles ; 13. Introduction of concave lenses ; 14. LEONARDO DA VINCI ; 15. FRACASTORO ; 16. MAUROLICO ; 17. LEONARD DIGGES ; 18. FELIX PLATTER ; 19. G. B. DELLA PORTA ; 20. FABRIZIO AB AQUAPENDENTE ; 21. Empirical discovery of the telescope and compound microscope (between 1591 and 1608, probably nearer the later than the earlier date) ; 22. GALILEO, the effective discoverer of both ; 23. KEPLER and M. A. DE DOMINIS. G. S.

26. — PHYSIOLOGY

Roberts, Morley. Warfare in the human body. Essays on method, malignity, repair, and allied subjects. With an introduction by ARTHUR KEITH. XIII + 286 p. London, EVELEIGH NASH Co., 1920. 1818

See W. M. BAYLISS' review in *Nature*, vol. 106, 622-4, 1921. G. S.

Wageningen, J. van. Die Namen der vier Temperamente. *Janus*, t. 23, p. 48-55. Leyde 1918. 1818

This notion of four temperaments developed slowly in antiquity; the four names : *melancholici, phlegmatici, cholerici, sanguinei* are not earlier than the 12th cent. G. S.

27. — PREHISTORY

Burkitt, M.-C. A study of early cultures in Europe and the Mediterranean Basin, XX + 438 p. Cambridge University Press, 1921. 1818

Burkitt, M.-C. Prehistoric art in caves and rock shelters. *Nature*, vol. 107, 460-4, London 1921. 1819

Moodie, Roy-L. New observations in paleopathology. *Annals of medical history*, t. II, 241-247. New York 1919. 1818

Tyler, John-M. The new stone age in Northern Europe, XVIII + 310 p. London, BELL; New York, SCRIBNER, 1921. 1819

28. — PSYCHOLOGY

Schwarz, Oslas-L. General types of superior men. A philosophico-psychological study of genius, talent and philistinism in their bearings upon human society and its struggle for a better social order. Prefaces by JACK LONDON and MAX NORDAU, 435 p. Boston, BADGER, 1916. 1818

Smith, W. Whately. A theory of the mechanism of survival : The fourth dimension and its applications, XI + 196 p. London, KEGAN PAUL, 1920. 1818

29. — RELIGION. HISTORY of RELIGION RELIGION and SCIENCE

Casanowicz, I.-M. Descriptive catalogue of the collection of ecclesiastical art in the United States National Museum. *Proc. of the U.S. National Museum*, vol. 55, p. 605-49, pl. 60-97. Washington, 1919. 1818

This interesting and well illustrated catalogue with brief but sufficient explanations of the signification and use of the various objects, is limited to the ritual branches of Christendom, that is, the Roman Catholic and Eastern Churches (Orthodox, chiefly Russian, and Armenian). There are 263 items. The inclusion of two models relative to the Church of Jesus Christ of Latter Day Saints (Mormons) is an incongruity. G. S.

Hardwick, John Charlton. Religion and science. From GALILEO to BERGSON. IX + 148 p. London, Society for promoting Christian knowledge, 1920. 1818

Little, Andrew George. A guide to Franciscan studies (*Helps for students of history*). 63 p. London, Society for promoting Christian knowledge, 1920. 1818

Roscher, Wilhelm-Heinrich. Der Omphalosgedanke bei verschiedenen Völkern, besonders den semitischen. Ein Beitrag zur vergleichenden Religionswissenschaft, Volkskunde und Archäologie. *Berichte d. Sächs. Gesell. d. Wiss., phil. Kl.*, t. 70, 115 p. Leipzig 1918. 1818

ROSCHER traces the notion of a navel of the Earth among various peoples: Chinese, Turkish, races of S. Siberia, Assyrians and Babylonians, Jews, Moslems, Greeks, Egyptians, Romans, Etruscans, Germans, Celts, California Indians. See also *Isis*, IV, 428, 443. G. S.

Wetter, Gillis P. Phōs (Φῶς). Eine Untersuchung über hellenistische Frömmigkeit zugleich ein Beitrag zum Verständnis des Manichäismus. *Skrifter utgifna af K. Humanistika Vetenskaps-Samfundet*, t. 17, IV + 189 p. Uppsala 1915. 1818

1. Das Licht physisch gedacht; 2. Das Licht für mehr religiöse Vorstellungen; 3. Herkunft der Lichtgedanken. G. S.

30. — SCIENCE

B. — *History.*

Cattell, J. McKeen and **Brimhall, Dean R.** American men of science. A biographical directory. Third edition, VIII + 808 p. 4°. Garrison, New York. The Science Press 1921. [Ten dollars]. 1818

The first ed. (1906) contained c. 4000 biographies, the second (1910) c. 5500. The present ed. contains c. 9500, and this increase in the main measures the increase in the number of scientific men. This directory is truly admirable and should be taken as a model in other countries. P. 771-780 contain a list of the American men of science who died between 1903.01.01 and 1920.12.31. The book ends with a study by CATTELL on « Families of American men of science » (reprinted from *Popular Science Mly.* May 1915, and *Scientific Mly.*, March, Oct. 1917). This study is not out of place, as it may seem at first view, for it emphasizes the fact that a directory of this kind, however great its immediate and practical utility may be, serves also a higher purpose. The authors of this excellent book have rendered a high service to American science : it will be more fully appreciated a hundred years hence. G. S.

Johnson, E. H. Some observations concerning the history of science. *School science and mathematics*, t. 21, p. 450-453, May 1921. 1818

Matschoss, Conrad. Das Deutsche Museum in München. Ein Haus für die Meisterwerke der Naturwissenschaft und Technik. [Undated reprint from *Industrie und Technik*. 5 p., 11 illustr.]. 1818

A general and popular account of the Museum. G. S.

Rey, Abel. Revue d'histoire des sciences et d'histoire de la philosophie dans ses rapports avec les sciences (année 1920). *Revue de synthèse historique*, t. 31, p. 121-135. Paris 1920. 1818

This paper is quoted chiefly because its ambitious title might mislead the reader. It deals neither with the history of science as a whole nor with the year 1920, and the author's choice is somewhat capricious. The authors dealt with are P. TANNERY (1912), P. DUHEM (1913-1917), JOHN

Burnet (1919), P. Boutroux, Fl. Cajori (1919), Halsted, Child, M. Delacre. G. S.

C. — *Organization.*

Kaye, George William Clarkson and **Laby, T. H.** Tables of physical and chemical constants and some mathematical functions, 4th ed. VIII + 161 p. London, Longmans, 1921 (Ist ed., 1911). 1818

Mills, John. The realities of modern science. An introduction for the general reader, X + 327 p. New York, Macmillan, 1919. 1818

Soddy, Frederick. Science and life. Aberdeen addresses, XII + 230 p. London, John Murray, 1920. 1818

D. — *Philosophy.*

Campbell, Norman Robert. Physics. The elements, X + 565 p Cambridge, University Press, 1920. 1818

Part I. The propositions of science : 1. Subject matter of science; 2, 3. Nature of laws; 4. Discovery and proof of laws; 5. Explanation of laws; 6. Theories; 7. Chance and probability; 8. Meaning of science; 9. Science and philosophy.

Part II. Measurement : 1. Fundamental measurement; 2. Physical number; 3. Fractional and negative magnitudes; 4. Numerical laws and derived magnitudes; 5. Units and dimensions; 6. Uses of dimensions; 7. Errors of measurement, methodical errors; 8. Errors of consistency and the adjustment of observations; 9. Mathematical physics. Index.

Driesch, Hans. Uber die grundsätzliche Unmöglichkeit einer « Vereinigung » von universeller Teleologie und Mechanismus. *Sitzungsberichte der Heidelberger Akad. d. Wiss., philos. hist. Kl.*, t. V. 1914, 18 p. 1818

Jenkinson, J. W. [1871-1915]. Science and metaphysics. *Studies in the history of science*, vol. II, 447-471. Oxford 1921. 9151

Marvin, F. S. Science and the unity of mankind. *Studies in the history and method of science*, vol. II, 344-358. Oxford 1921. 1818

Marvin explains that science is essentially of a social nature; he then shows that its growth has been accompanied by a closer knitting up of the world as one community; finally he considers the actual links which science has forged for the process of unification and what it may do in the future to hasten it. G. S.

Schiller, F. C. S. Hypothesis. *Studies in the history and method of science*, vol. II, 414-446. Oxford 1921. 1818

33. — SUPERSTITION and OCCULTISM

Leclerc, Henri. La médecine des signatures magiques. *Janus*, t. 23, 5-28. Leyde 1918. 1818

Ce travail a été attribué par erreur à Leclerc, c'est l'œuvre de Saintyves (voir *Janus*, t. 24, 192). G. S.

Redgrove, H. Stanley. Bygone beliefs. Being a series of excursions in the byways of thought, XVI + 205 p., 32 pl., 53 fig. London, RIDER, 1920. 1818

These collected essays have been partly published in *The Journal of the Alchemical Society* and in *The Occult Review*, which will suffice to indicate their character : 1. Some characteristics of mediæval thought; 2. PYTHAGORAS and his philosophy; 3. Medicine and magic; 4. Superstitions concerning birds; 5. The powder of sympathy; 6. The belief in talismans; 7. Ceremonial magic in theory and practice; 8. Architectural symbolism; 9. The quest of the philosopher's stone; 10. The phallic element in alchemical doctrine; 11. ROGER BACON; 12. The Cambridge platonists.

G. S.

Rivière, Émile. Légendes et superstitions thérapeuthiques. *Bull. soc. franç. méd.*, t. 13, 82-94, 160-171, 385-443. Paris 1914-1919. 1818

35. — ZOOLOGY

Fuertes, Louis Agassiz. Falconry, the sport of kings. *The national geographic magazine*. Vol. 38, 429-460, illustr. Washington, December 1920. 1818

Falconry or hawking goes back to the early days of Egypt. It was practised by the Persians; the Lombards of N. Italy knew of it c. 560; by 875 it had become a generally known practice throughout W. Europe. This article by the master birdpainter FUERTES is of great interest because of the illustrations (many in color) showing very clearly how the birds strike their victims, and of the explanations of the gear and trappings used in falconry and the falconer's names for the parts of a hawk. G. S.

McClymont, James R. Essays on early ornithology and kindred subjects, 35 p., 3 pl. London, QUARITCH 1920. [200 copies]. 1818

Six essays : 1. The rukh of MARCO POLO (an imaginary bird); 2. The penguins and the seals of the Angra de Sam Brás (nr. the Cape of Good Hope), apropos of the « Roteiro da Viagem de VASCO DA GAMA em 1497 » (the second record of an important voyage of discovery containing information on natural history, the first being the journal of the first voyage of COLUMBUS); 3. The Banda islands and the Bandan birds; 4. The etymology of the name Emu (may be of Arabic origin, neâma', or of Portuguese origin, hema 1576); 5. Australian birds in 1697 (apropos of the Dutch voyage under WILLEM DE VLAMING); 6. New Zealand birds in 1772 (apropos of NICOLAS THOMAS MARION DUFRESNE'S voyage; CROZET, second in command of the Mascaret, made not a few ornithological observations). G. S.